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BROOKLYN BOTANIC GARDEN

LEAFLETS

Series IX Brooklyn, N. Y., April 6, 1921. No. 1

The Brooklyn Botanic Garden gives its third annual course of spring lectures, free to the public, on Fridays at 4 o'clock, from April 8 to April 29. This year the theme of the lectures will be "The Flower Garden." Our lecturers have been asked to tell briefly the ground they are to cover in their lectures, so that the public may come having some idea of the subjects and personalities of the lecturers. Following are the dates, subjects, names of the lecturers, and a brief outline of the talks.

APRIL 8.—THE FLOWER GARDEN: ITS PLAN AND ARRANGEMENT by Miss Grace Tabor, Author, Editor, and Landscape Architect, New York City.

"The term flower garden does not necessarily imply size or magnitude of gardening operations—but it does imply a garden concept rather than a hit-or-miss use of flowers. Generally speaking, this garden concept is what we lack; and when it is perceived, it still fails to take into consideration the necessity for close association between house and garden, hence we seldom arrive at the actually livable garden, here in America. As one of the first reasons for having a garden is that it may be enjoyed, it is essential that this quality of livableness be its chief characteristic (since we can fully enjoy only through intimacy and close association), therefore instead of proceeding to the development of a flower garden through study and consideration of the plants which go to adorn it, the first thoughts should be given to its situation and form with relation to the house,—of which it is to be regarded as a continuation,—or perhaps more exactly, the complement. Rightly placed and planned, it will then afford the fullest opportunity for making acquaintance with its occupants, the flowers; whereas, if it is not right in its fundamentals of place and form, it never will facilitate such acquaintance. And though the gardener may persist and may come to a very complete horticultural knowledge notwithstanding, his efforts must be greater while his results will never be as convincing."

APRIL 15.—THE MEANING OF A FLOWER, by SAMUEL CHRISTIAN SCHMUCKER, Professor of Biological Sciences, State Normal School, West Chester, Pa.

"We who enjoy the exquisite beauty of the flower, are very apt to believe all this beauty is made for us. But the structure of a flower has so clear and so definite a purpose and accomplishes so good a result when it works out this purpose, that we can have little doubt as to the meaning of a flower. All the beautiful adornment of the flower is meant to attract the insects, who, coming for the nectar, carry pollen from flower to flower thus insuring seeds. The remarkable part of the process however, is that by carrying pollen from one plant to another they carry into the new seed the qualities of the father plant, while the plant to which the pollen is carried gives to the seed the qualities of a mother plant. Thus Nature is forever giving to all her higher children two parents instead of one. The purpose of this is to secure an ever new assortment of the qualities of two individuals, trusting that amongst the combinations that arise, some will be so much better than others as to produce new strains from which Nature can work to higher levels. Much of the improvement in the animal and plant world has come from this mingling of strains and the selection of the best."

APRIL 22.—FLOWER ARRANGEMENT, by MR. B. F. LETSON, Boston, Mass.

"I begin my lecture with the care of flowers from the time of cutting or receiving until they are used. I shall demonstrate the right and wrong methods of cutting flowers, and the use of receptacles for the best results. I also give a treatise on first aid to wilted or chilled flowers. Illustrations will be given of combinations of flowers with regard to color, form, and the right relation of one flower to another. I shall bring flowers and receptacles to demonstrate the talk."

APRIL 29.—COMMON GARDEN FLOWERS: HOW THEY MAY BE IMPROVED. DR. ORLAND E. WHITE, Curator of Plant Breeding, Brooklyn Botanic Garden.

"There is a friend of mine who comes to see me almost every week. One of the subjects we invariably discuss is the beauty and joy of owning and cultivating a little farm—a little farm with water gardens, flower beds, and trailing vines over a high-peaked roof. Sometimes we spend the whole evening discussing this hobby. In our imagination we have developed a beautiful country place—a beautiful picture. For seven years we have been doing this, yet it is still in the air-castle phase, and privately I think it will always remain so. The trouble with us Americans, as some foreigner has said, is that we love to lecture and be lectured to about many things that ought to form a fundamental part of our lives. The love of good books and the love of beautiful surroundings are two of these. Beautiful surroundings mean flowers. Flowers mean eventually varieties and improved strains especially adapted to our multitudinous environments. How are we to get them? In the past we have depended largely on Europeans. Hence most of our best flower varieties are either pro-French, pro-British, or pro-German in the sense that they were originated by these peoples. If a generous lover of flowers wished to erect a statue to the man who has done the most in improving sweet peas, the statue would represent Henry Eckford of Wem, England. If it were an Iris enthusiast who wished to commemorate his appreciation for the man or men responsible for the great variety of Irises, the bronze or marble would be French, English, German or Japanese in countenance. Or again, when the intelligent gardener offers up his paean of praise for the magnificent varieties of lilac and gladioli, Lemoine of Nancy, France is the recipient.

"The lecturer believes that we should be able to individualize our American civilization in regard to our flowers, as we have already done in many other directions. We should have thousands of amateur plant breeders in this country, instead of a few hundreds. And we should breed our own flowers our own selves, instead of hiring it done either by importing the seeds or plants or the men themselves as gardeners from abroad. The great English, French and German gardening societies are composed of rich and poor, of people having in common a love for getting the best out of the floral life of their own and other countries by civilizing, so to speak, the wildlings. This is floral exploration—this is an outlet for their love of creating something. The art of plant breeding is simple. There are no secrets, nor is wizardry involved. Mostly what is required is enthusiasm, patience, and love of flowers and working with them. No great company need be capitalized. I dare say many a new variety is the product of some small garden patch or some humble back yard. The lecturer will tell what can be done with our common garden posies by those with the above attributes."

PLANTS NOW IN BLOOM

Among the woody plants in flower about the time this LEAFLET is issued, is the Spice Bush (*Benzoin aestivale*), which has small yellow flowers borne on the leafless twigs, and is a native of eastern North America. It is in the Local Flora valley. Also, *Alnus glutinosa*, a European tree alder, related to our own swamp shrub, will be in flower. It bears its conspicuous flowers in drooping catkins. One of the most showy shrubs or small trees to bloom before the appearance of its leaves is the Cornelian Cherry (*Cornus Mas*). This plant is covered with hundreds of tiny yellow flowers on the otherwise naked twigs. Among the herbs one of the earliest flowering is the Coltsfoot (*Tussilago Farfara*). Its showy orange-yellow heads, resembling dandelions, are borne at the end of a scaly flower-stalk, and have, over a period of ten years, bloomed between the 17th of March and the middle of April. This year it should be in full bloom about the 6th of April. Numerous other species in the rock garden and in the wild flower collection will also be in bloom by the time this LEAFLET is issued.

NOTICES

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays at 10 a m. The Laboratory Building, containing the library, herbarium, and offices, is open daily (except Sundays), from 9 a. m. until 5 p. m. (Saturdays, 9–12). The Conservatories are open April 1–October 1, 10 a. m.–4:30 p. m. (Sundays, 2-4:30); October 1–April 1, 10 a. m.–4 p. m. (Sundays, 2-4).

Subscription for LEAFLETS **fifty cents a series** (comprising ten or twelve numbers); free to members of the Botanic Garden and to teachers.

The LEAFLETS are published weekly or biweekly from April to June, and October to November, inclusive, by The Brooklyn Botanic Garden, Brooklyn, N. Y.

Telephone: 6173 Prospect. Mail address: Brooklyn Botanic Garden, Brooklyn, N. Y.

CHILDREN'S NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES IX BROOKLYN, N. Y., APRIL 20, 1921. NO. 2

EIGHTH ANNUAL GARDEN EXHIBIT FOR BROOKLYN BOYS AND GIRLS

Time—The eighth annual Garden Exhibit for the boys and girls of Brooklyn will be held September 23 and 24. Note that September 23 falls on a Friday. We planned this. Why? So your teacher could bring your class in school time, if your principal is willing. Isn't that good? The exhibit will be open on these exhibit days from 10 a.m. to 4 p.m.

Place—Our exhibit will be held in the central rotunda of the laboratory building, at the Botanic Garden. The building may be entered either from Washington Avenue, No. 978, or from the Garden side.

Conditions of Entry—Be sure that each separate exhibit, unless it be a part of the class or school exhibit, has an entry card with the exhibitor's name, school, and address upon it. These entry cards may be had from us in early September, and should be filled in exactly as indicated. Bring the exhibits to the Botanic Garden on September 22, between 9 a.m. and 3 p.m.

Time of Judging—Three expert judges will judge these exhibits and make public their decisions on September 23, at 10 a.m.

Prizes—1. *Individual.* These prizes are gold medals as First, and bronze medals as Second Prizes.

2. *Group.* Prizes in *Classes A*, *B* and *C* are won by groups of boys and girls working together. The FIRST PRIZE in *Class A* is a trophy for which P. S. 98 and P. S. 89 are tied, each having won it for two years. The SECOND PRIZE is a silver cup. FIRST and SECOND PRIZES in *Class B* will be silver cups, which remain, when won, as the permanent property of the school or association. This year *Class C* has, as a FIRST PRIZE, a loving cup. A bronze statue of Victory was won by P. S. 43 in 1920. One school winning our trophy three times is entitled to retain it permanently. The SECOND PRIZE will be a silver cup.

Removal of Exhibits—Exhibits may be taken away by the exhibitors at 4 p.m. on September 24, or at any time before the 28th.

Presentation of Prizes—Prizes, both individual and group, will be presented on October 8, at 2:30 p.m., in the auditorium of the Brooklyn Botanic Garden building. No prize winner will receive his prize unless he is present, or sends a substitute, on October 8.

To be Noted—Read over instructions concerning *Class K*. To enter this contest, apply at once by letter or otherwise on or before July 1 to the Curator of Elementary Instruction, at the Brooklyn Botanic Garden. An enrollment card will be sent to you. These prize gardens will be visited during the summer. For the prizes in this class and the conditions for entry read under instructions for *Class K*.

To be Specially Noted—*The Alfred T. White Scholarship*. What is it? A college scholarship of $100 for the boy or girl working at least two seasons at the Brooklyn Botanic Garden and showing marked ability in High School Biology. It was given for the first time in 1920 and will be given annually hereafter. Harold Uhrbrock, of Manual Training High School, won this scholarship and is now at Cornell University. How can I become a candidate for the Alfred T. White Scholarship? By applying at once to the Brooklyn Botanic Garden, and then keeping busy with your hoe, and your biology books, and by your efforts toward being an all-round good young citizen of the Borough of Brooklyn.

Class A—**School Display.** FIRST PRIZE, a trophy to the school making the best display, to be held for a year only, or until won three times, when it becomes the permanent property of the winning school. SECOND PRIZE, a silver cup. This year we want some new schools to try for this. See if this year your school cannot send in the best collection of vegetables, flowers and plants. These may be raised either at schools or in home gardens.

Class B—**Community Garden Display.** *Class B* differs from *Class A* in several respects. In the first place, *Class A* must be the work of a school, either supervised or non-supervised work. It usually is the latter. *Class B*, the Community Garden Display, is represented by those schools having instructions throughout the summer—for example, school gardens under the supervision of the Board of Education, gardens under the supervision of the Park Department, or community gardens under the supervision of a paid instructor. The FIRST PRIZE in this exhibit is a silver cup; the SECOND PRIZE, a silver cup.

Class C—**Box Display.** This display will consist of six sample window boxes from each school entering *Class C*. There are schools where it is impossible to have a school garden, and where the neighborhood is such that it is impossible to have home gardens; for such, this class is added. The FIRST PRIZE in this exhibit is a beautiful loving cup, which shall be competed for under the same conditions as those for the trophy in *Class A*. SECOND PRIZE, a silver cup.

Class D—**Flowers.** This is a class for individual competition, and in which first and second prizes are offered. In this and the following classes the FIRST PRIZES are gold medals; SECOND prizes, bronze medals. Certificates of honorable mention will be given as third prizes. If a boy or girl enters an individual class, he must understand that these same products cannot count toward his school display. Double entries should be made in such cases. Do not forget this. If you enter zinnias for an individual prize and wish to add zinnias to the school display, then you must bring two bunches of zinnias. The divisions in *Class D* are as follows:—

No. 1. Ageratum
Best 4 sprays
No. 2. Alyssum
Best plant (potted)
No. 3. Asters, blue
Best collection of 10
No. 4. Asters, pink
Best collection of 10
No. 5. Asters, white
Best collection of 10
No. 6. Asters, mixed
Best collection of 12
No. 7. Asters
Best plant (potted)
No. 8. Calendula
Best collection of 8
No. 9. Cornflower
Best collection of 12
No. 10. Dianthus
Best collection of 10
No. 11. Marigold
(Giant African)
Best collection of 12
No. 12. Marigold
(Dwarf French)
Best collection of 12
No. 13. Marigold
Best plant (potted)
No. 14. Nasturtium
Best collection of 12
No. 15. Phlox
Best collection of 8
No. 16. Sunflower
Largest flower
No. 17. Verbena
Best collection of 10
No. 18. Zinnia
Best collection of 10

Class E—**Vegetables.** Surely this ought to be a popular class this year. Plan ahead so your vegetables will be in their prime at exhibit time. Try to send in perfect specimens. If, for example, you are exhibiting under No. 17, red tomatoes, have your eight tomatoes as near the same size as possible. Wash your vegetables carefully, so that they make an attractive appearance. First prizes in this class are gold medals; second prizes, bronze medals; third prizes, certificates of honorable mention.

Divisions in Class E

No. 1. Beans, bush
Best pint, shelled
No. 2. Beans
Best quart, unshelled
No. 3. Beets
Best bunch of 6
No. 4. Carrots
Best bunch of 5
No. 5. Cabbage
Best head
No. 6. Corn
Best 6 ears.
No. 7. Egg-plant
Best 2
No. 8. Kohlrabi
Best 4
No. 9. Lettuce
Best 2 heads
(roots and all)
No. 10. Onions
Best 4
No. 11. Peppers
Best 4
No. 12. Potatoes
Best 6
No. 13. Pumpkin
Best specimen
No. 14. Radishes
Best 8
No. 15. Squash
Best specimen
No. 16. Tomatoes, green
Best 8
No. 17. Tomatoes, red
Best 8
No. 18. Tomatoes
Small-fruited varieties
Best 10

Class F—**Best Special Plant.** Any plant cared for by the exhibitor may be entered. The plant may be a geranium raised from a cutting, an aster from a seed, a fern from a runner—it matters not so long as the work is yours. The plant stands no chance of prize winning if it is not in good condition, clean, properly potted, and free from insect pests. FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, a certificate of honorable mention.

Class G—**Best Bunch of Flowers.** Judged on perfection of the flowers and taste in arrangement. FIRST PRIZE in this class is a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, a certificate of honorable mention.

Class H—**Individual Garden Display.** The greatest variety of flowers or vegetables raised by one child constitutes this display. Here is an opportunity to show some originality and taste in the way you put together and arrange your own exhibit. Let us have more exhibits in this class this year. FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, a certificate of honorable mention.

Class I—**Weed Display.** This weed exhibit may be one of either fresh or pressed specimens. No exhibit can take a prize unless the specimens are carefully and correctly named. If you go away to the country in the summer you will have a good opportunity to make a large collection of weeds and wild flowers for the exhibit. FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; and certificates of honorable mention will be awarded to those taking third places.

Class J—**Wild Flowers.** Similar to *Class I*. FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, certificates of honorable mention.

Note.—No individual may carry off more than one first and one second prize in *Classes D* to *J* inclusive.

Class K (a)—**Back Yard Gardens.** Boys: Two fine nature books will be presented to the boy having the best back yard garden in Brooklyn. One nature book will be given to the boy having the second best back yard garden. Conditions for these prizes are as follows: First, the garden must be kept by the applicant; second, the garden must be at least 10 x 20; third, plans, diagram, costs of seed, amount of crop must be all submitted in writing to the Botanic Garden at the time of the exhibit. These gardens must be entered in this contest by July 1st, and will be visited at least twice during the season by a judge from the Botanic Garden.

Class K (b)—Same for girls as *Class K (a)*.

ELLEN EDDY SHAW,
Curator of Elementary Instruction.

Note.—Competitors under *Classes A, B* and *C* should ascertain their allotted exhibit space by September 15, from the Curator of Elementary Instruction.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES IX BROOKLYN, N. Y., MAY 4, 1921. NOS. 3 AND 4

THE POLLINATION OF FLOWERS

> "In all places, then, and in all seasons,
> Flowers expand their light and soul-like wings,
> Teaching us, by most persuasive reasons,
> How akin they are to human things."
>
> —LONGFELLOW.

> "The play of stamens and pistil, the seduction of perfumes, the appeal of harmonious and dazzling colours, the concoction of nectar, * * * —that is to bring to the flower the kiss of the distant, invisible, motionless lover."
>
> —MAETERLINCK.

The story of pollination in flowers is a part of the story of sex in plants—a story that began with the first primitive green thing that grew in the ancient seas. Millions of years have passed since then—a period of time as vast and as inconceivable as the spans of space that separate the stars. Flowering plants, so those who study the rock-written pages of the earth tell us, began somewhere around five million years after the great, gloomy fern and club moss forests that gave us our coal, had passed away. That period was a momentous one for the human race, although even the remotest hint of the coming of man was not yet apparent. The Appalachians, of which the Palisades and Orange Mountains are a part, were new then. The Rocky Mountains still slumbered beneath oceans of water and stretches of undulating plains. Our mammalian or milk-giving ancestors were extremely insignificant, and mostly lived as small animals in the trees. Reptilian monsters of enormous size dominated air, land and water. The sequoias, now represented only by the redwood forests of our Pacific coast and the "Big Trees," were scattered broadcast over the northern hemisphere—perhaps as plentiful as the pines are to-day. In all probability, the first flowering plants were semi-aquatic, marsh-like beings—one foot on land, and one in water—insignificant, humble individuals with net-veined leaves and very inconspicuous, comparatively scentless flowers—giving no clue of the immense dormant potentialities that later expressed themselves as we know them,—giving no hint of the gorgeous colors, of the marvelous diversities of form and perfume that we find among the 125,000 or more species that now struggle with each other to cover and dominate the earth.

When the little fox-sized Eocene horse first made its appearance in Western America, forests of willow, oak, laurel, poplar and maple were abundant, and broad plains were covered with grasses and sedges. Figs, magnolias and palms flourished much further north than now, and even the ancient relatives of our tropical breadfruit grew as far north as Oregon. Bees, wasps and flies buzzed industriously about. Moths and butterflies flitted over the prairies and through the forest aisles, then as now, though perhaps they had not yet become so plentiful or so diversified. Alligators and numerous other saurians nosed their way sluggishly and gruntingly through the tall sedges. In general, the country is said to have worn the aspect of our Louisiana of to-day.

So in that distant time, when years were still largely seasonless, when the earth was mainly bathed in perpetual and monotonous summer, the great struggle between the old club-moss, conifer, fern forests, and swamps, and the new angiospermous or flowering plant communities took place. Foot by foot the latter has made headway until now the former are mere relics of what they once were—relegated to favorable nooks and crannies such as mountain regions, certain poverty stricken soils and isolated islands,—and even these favored remnants will soon pass if the hand of man is not stayed. On some of the mountainous hillsides of the Yellowstone National Park, great petrified trunks of ancient redwoods now stand like monumental gravestones overlooking a sea of verdure composed largely of populous communities of their successful rivals. Half buried in the desert sands of northern Arizona, the great agatized Araucarian logs lie piled in heaps, surrounded by sage brush and other modern representatives of the newer flora, while their own few remaining outposts are far away in South America, Australia and New Zealand.

So rapidly, apparently, did the flowering plant spread after it had once arrived, that many scientists have pondered on why this type was so eminently successful. So well adapted to the regions of our earth were they, even in the infancy of their existence, and so few connecting links with the older type of vegetation they replaced have been found, that Darwin often speculated as to whether they had not come from some huge, southern continent that had since sunk beneath the ocean.

The answer to these questions, in part at least, is found in the relations that exist between the flowering plants and the insects. For both appeared on the evolutionary stage at about the same time. As is well known to-day, plants and insects are often mutually helpful to each other, especially those insects we know as bees, wasps, flies, moths and butterflies. The plant provides food, the insects act as "marriage brokers" or "go-betweens," and through pollination insure the production of seed through which the various species multiply themselves. There are other agents than insects involved in this work, of course, but probably the majority of flowering plant species are insect pollinated, and it is perhaps to the insects they owe their great diversity.

The other most important agencies are the wind, the water, snails and small birds, especially the humming birds. The great coal forests were wind pollinated, and so were most of the early representatives of the flowering type, such as the poplar, the maple, and the grasses and sedges. And these and others to the extent of about 10,000 species are still pollinated through this agency.

But what do we understand by the word flower? Flowers are usually described as whorls of modified leaves which are involved in producing seeds—in other words—the seed manufactories of plants. The whole apparatus is designed for this purpose, though most of us have always thought of flowers as something contrived for the pleasure of human beings, or to give beauty to a landscape, or to furnish food for such insects as bees and butterflies.

But these are not at all the purposes for which the plant goes through such initial preparation in order to blossom. Witness how soon they fade after pollination. To prevent this, the florist often removes the stamens in Easter lilies and other flowers. Many plants, such as grasses, maples, and walnuts have flowers the very reverse of showy, and have no honey. Especially is this true of many wind-pollinated plants. In a generalized flower there are four whorls—the outer generally greenish, known as the calyx; the inner corolla of petals, often bright colored and very showy; the stamens or male portion, and the pistils or female whorl. All these whorls have been modified through evolutionary processes, so that in many cases an expert is required to identify them. Some of the whorls may have been lost or reduced to almost the margin of inconspicuousness. In thousands of species all the petals have been partly or wholly fused as in the blueberries and the bellflowers. In other types, such as those of the orchids and the pea family, the symmetry and regularity has been twisted and distorted so much that they remind one of monstrosities or those grotesque ornaments one used to see on mantels in our forefather's day. The daisy family has large numbers of small flowers crowded together, slum fashion, in the smallest possible space and surrounded by a green dentilled wall of little leaves or bracts. In the poinsettia and bougainvillea the green wall is replaced by brilliant red and purple leaves and the slum condition somewhat modified by the presence of fewer flowers. The calyx and similar structures are generally for protection, while the bright colors are, like the electric signs on Broadway—advertisements of wares to be had—for a consideration, of course. And so are the scents. They take the place, in the dumb life of the plant, of the town crier and the hawkster's voice. But the really important parts of the flower are the stamens and the pistils. And these again are as diversified in form and color as their owners.

The mature stamens are usually made up of two little sacks of golden orange dust, from which the contents are blown by the winds to other plants, or carried by insects from flower to flower in order that seeds may have fathers and mothers not too closely kin, and that the different character rudiments may mix, perchance to give rise to offspring with new and yet untried combinations of characters—perchance to give rise to still more adaptable and progressive offspring.

While pollen to the unaided human eye appears as mealy flour or oily dust, a microscope brings forth great surprises. All sorts of fantastic shapes appear upon magnification—sculptured, smooth, grooved, covered with horny protuberances, or even with thorns, varying greatly in size, sometimes bound together in sets of four as in some heathers and the bearberry, or with long bonnet streamers as in the willow-herb and evening primroses. In some of the water plants the pollen grains remind one of tiny submarines. Many of these structures are helpful, while others may be a positive hindrance, just as some of our own organs appear to be, the appendix for example. A few kinds of pollen are water resistant, but most sorts easily spoil if wetted—often swelling till they burst like a toy balloon. In a former leaflet (The Crossing of Flowers) illustrations and descriptions of pollen grains, fertilization, and pistils are given.

The mother element of a flower is the pistil, usually placed like a tall graceful vase or a set of them, in the centre of the flower, with a sticky, sugary mouth, and a flask-like hollow base full of ovules or tiny transparent seed cases, each containing a plant egg.

The pollen, as contrasted with the ovules, is not well protected, but it generally balances this by being very plentiful—so plentiful in fact that when the pine and spruce woods are in bloom the wind often deluges a nearby town in "sulphur showers"; —so plentiful that much of the cannel coal, as well as some other kinds of coal, are made up largely of trillions upon trillions of carbonized, crushed pollen grains.

Flowers do, however, have all sorts of devices for protecting their pollen from the wet, however generous and careless they seem to be with it. In countries such as Australia and parts of Africa, with a dry and a rainy season, the great blooming period comes at the close of the latter. Hence, such plants as the acacias, wattles and other plants of the "scrub" or "bush" need no special devices. In spring-shower and mountainous regions where plants like the heathers, blueberries and campanulas abound, the flowers are bell-like and hang at angles sufficient to ward off the rain. In the moist rain belts of tropical regions plants such as the banana and its relatives have showy, bright colored sheaths which protect the flower until after pollination, when they fall off and dry up. Another device is the spathe or cowl-like hood, covering the whole cluster in many of the arums, familiar examples of which are the callas and the skunk cabbage. The linden tree prevents wetting its pollen by a little oblong leaf that hangs above its flower cluster, which conducts away the rain drops much as a slanting board over one's head would. The iris or flag has utilized part of its pistil, turning it into an over-turned trough-like structure, under which one finds a single stamen safely housed. Snap-dragons, calceolarias, and the members of the pea family have hood-like corollas, while in the upright, apparently fully exposed phloxes and primroses, the stamens remain in the corolla tube or throat, protected from the raindrops by the compressed air cushion brought into existence by the drop itself and the slightly contracted mouth of the tube. Magnolias, crocuses, flax, peonies and certain water lilies close their flowers at night or in damp weather, while the brilliant California poppy sheds its pollen on the flower floor and then covers it in inclement weather or at night with its four petals, each neatly curled up like a cornucopia tent. Some plants are so sensitive to the intensity of light or to cloudiness that they can close their pollen sacks or anthers on short notice and open them again in equally quick time. Plants such as the colts-foot, rock-rose, some poppies, scabiosa, and some wild geraniums bend their flowers or flower clusters, not in reverence toward their Creator as some sentimentalists might say, but indirectly because of the approach of harmful weather.

While only protective devices against weather have been mentioned, be assured that most of the flower creation have equally sufficient instruments for warding off pollen marauders. These take a multitudinous variety of forms, from pollen sacks with lids that can only be opened by the elect, to small armies of ants that fight off their leaf-cutting relatives because the attacked plant is their own home and food supply. Some plants protect their flowers against ants and other such useless, but persistent visitors, by a secretion of sticky substance on their flower stems, or on the green-toothed wall that often surrounds the whole flower cluster, as in the sunflower and the dandelion. The thistles use both thorn and sticky substance. Perhaps you have noticed the dead bodies of ants and other pedestrians sticking, like flies on "tanglefoot," to the outside of the thistle flower, or on some of the gummy sunflower tribe. So commonly is this the case with some of the pink family, that they have long been known under the name of "Catch-fly." You recognize, of course, that this is the same scheme we ourselves use to protect our shade trees when we use "tangle-foot" bands on their trunks. Possibly we first secured the idea from this source. Plants with these devices welcome only visitors arriving by air, and these devices are, in effect, notices: "Pedestrians not welcome." For these ants and other walkers give but little, if any return to the plant for the pollen and honey they take. Besides, they are even apt to attack the welcome winged visitors. Some plants provide honey at flowering time in their leaf axils, which serves to feed the horde of useless guests and protect their pollen stores far above in the flowers. Again, this is similar to our own tactics in dealing with crows and gophers, when we supply them with the more easily obtained uncovered grain, until the planted grain is too large to be harmed. Smooth, waxy stems are another sort of protection, as they make climbing difficult. Undoubtedly the deep, cavernous tubes in many flowers with their fringed mouths tend to keep out the timid, unadventurous type of marauder. For what may not be hidden beyond those fringe-like walls in the darkened depths? But even those bee visitors that are useful in most cases, may learn the ways of a parasitic life, and instead of rendering the usual service to their plant acquaintances, they mutilate them by biting a hole through the calyx or corolla and secure the honey in this less difficult fashion. There are said to be over 300 plants in the European flora whose flowers are thus robbed by bumblebees. And in a few cases this robbery threatens their very existence. Several species of "Catchfly" in Europe are thus afflicted, and because they rarely set seed, they are becoming more and more rare. I have often noticed little holes in the bell-shaped flowers of some of the wintergreen family, perhaps made for the same purpose—illegitimate honey-taking.

One must bear in mind that many of the devices mentioned above have other uses to the plant than those noted, perhaps of a totally different character, just as we have windows to see through and to let in sunshine, but which also keep out dust and cold air.

The length of life of pollen varies as much as that of the various kinds of plants themselves. Pansy pollen is "good" for about 26 days, that of the peony for 60 days, while date palm pollen has been actually used with excellent results after it was ten years old. The Arabs save it from year to year as a precaution against a poor supply or a bad season. It has been said that corn, tobacco and date-palm pollen will live for 18 years, but this may be a gardener's tale. Tomato growers save tomato pollen from the summer flowers for use several months later on hot-house plants. Pollen of some grape species germinates after two months, and that of carnations after at least several weeks. Sweet cherry pollen remains alive for 28 days, nasturtium pollen for 88 days, while the pollen of some of the grasses dies in a day or two. The drier pollen is kept, the longer it lives. Nasturtium pollen wetted for 2 minutes and then dried, remained alive for two days, as against 88 days for the unwetted sample, while sweet cherry pollen in 60 percent humidity was viable for 25 days as against 126 days in air absolutely freed from moisture.

Flowering plants have many ways in which pollination is brought about, and some of these have such a relation to insects, snails, and other elements they make use of, as to sound almost incredible. I have no doubt that were I to relate some of them in a striking enough manner, and with the proper facial expression, my hearers would put me down as a nature faker. In the first place, the best interests of plants in general demand cross-fertilization or cross-pollination—that their seed should be the product of the union of pollen and eggs from different plants—in other words, the fathers should not be too near kin, even though most plants have both the father and mother elements in the same flower. The mingling of two different family lines tends to produce more vigorous and adaptable offspring, by bringing about the opportunity for two different sets of hereditary characters to be shuffled, card-game fashion, and thus form new combinations. So general is the plant's desire to prevent inbreeding that Darwin has said: "Nature abhors self-fertilization." Though in many cases, one must remember, that the plant has not yet experimented enough to prevent it. Of the many ways that plants preclude this, some of the more striking are self-sterility, or the incompatibility of the pollen and the pistil; dioeciousness, the separation of the two sexes in different flowers on separate plants; monoeciousness, or the separation of the two sexes in different flowers on the same plant; proterandery, the shedding of the pollen before the pistil of the same plant or flower is ready to receive it; and numerous special contrivances that prevent the pollen generally from being used on the flowers of the same plant.

Self-sterility is common among the poppies, the muscadine table grapes of the south, many tropical fruits, some varieties of flowering tobaccos, and numerous wild plants. Among plums the Green Gage, Grand Duke, Coe's Golden Drop, and Prune d'Agen produce no fruit if pollinated with their own pollen. Such apples as the Northern Greening and Cox's Orange Pippin remain barren if dependant on themselves for fertilization. In the case of cherries, the Black Tartarian, Black Heart, White Heart and Early Rivers, pass a fruitless existence unless planted so that the wind or bees or other insects can bring pollen from other varieties of cherries to their waiting pistils. Twenty-five years or more ago, great pear orchards of one variety, such as the Kieffer or the LeConte, were planted in the South, and at the proper age they blossomed profusely but remained pearless. Their owners sought our national agricultural department experts for aid and the discovery that these varieties were self-sterile was made. Trees of other varieties were planted in their midst and they ceased to be barren.

But even in these orchards of mixed varieties, barrenness would still have been the dominant note if it were not for the bees and other insects that go from flower to flower and from tree to tree gathering honey and distributing, unintentionally, of course, the precious pollen dust. Did it ever occur to any of you what a calamnity it would be if all the bees, wasps, moths, butterflies and flies of the whole world, through some strange freak of Fate disappeared forever from the earth this coming year? Only a generation would pass before many of our common plants would die out, because of their dependence on seed for multiplying themselves, and on these insects for helping to bring about the seed. Many orchards of certain varieties of fruit would shed their self-sterile flowers and become barren and useless. Of course, there would be left those plants which depend on suckers, runners, and other non-sexual means of multiplication, and those plants pollinated by the winds, and those that were fertile to their own pollen and that had flowers with both sexes present; also the plants artificially propagated by man. But it would be a terrible calamity.

Darwin, in his "Origin of Species," mentions the need of the heartsease, or wild pansy, and the red clover for the humblebee, and how, without his pollen-laden, honey-gathering visitations, these two plants would probably become extinct or at least very rare in England. And thereby hangs a tale, for it is said that these two plants exist by grace of the English maiden ladies. This happens thus: maiden ladies keep cats, cats kill field mice, and field mice destroy bumble or humble bees' nests, and of course, without the genus of humble bees, with their long tongues, wild pansies and red clover would be seedless and soon die out of old age. But the tale has been proved an improbable one, as with most tales of this type, for other insects are now known to assist in cross-pollinating these plants.

In the willows, poplars, the tropical papaw, the common "tree of heaven" or ailanthus, and hops, the two sexes are separated on distinct "male" and "female" plants. This scheme, like self-sterility, gives greater opportunity for bringing "new blood" into the family hereditary stream, just as it does among human beings. Did you ever examine the "pussy-willow," and note how the "pussies" on some trees are made up of little sacks of golden pollen, protected in a soft, warm plant-fur, and how the "female" trees do not have such striking "pussies"? As the spring advances, the pollen "pussies" turn into feathery golden flower clusters, and before the leaves are out to be in the way, the winds blow and the insects come and distribute this dust to the waiting pistils of the "female" trees and the pollen "pussies" dry up and fall off, while little seeds begin to grow in the clustered flowers of their less conspicuous mates. In hemp, the female plants are generally taller than the male plants. This is the very reverse of what one would ordinarily expect, since their pollinating agent is the wind. But in many plants dependent on the wind, the mature pollen, when exposed, tends to be carried in an upward direction, and floats away in little clouds, just as dust rises when disturbed, in a seemingly quiet atmosphere, or just as a smoke cloud rolls away from one's pipe on a quiet evening. Of course in many conifers this upward flight of the pollen is assisted by the winged nature of the pollen itself. In some other plants, the mature pollen is shot off in little clouds by an explosive apparatus. This is especially true of some nettles, and particularly of one of their tropical relatives known as the artillery plant (*Pilea microphylla*). In the latter case, if one sprinkles a bud-covered plant in the shade with water, and then places it in the sunshine, immediately the buds all over the plant explode and little clouds of pollen float away.

Probably the most anciently known example of dioeciousness in plants occurs in the date-palm. Possibly even before the historic period began, some five thousand years ago, the ancient inhabitants of the Mesopotamian region recognized the male and female trees of this palm and practiced artificial pollination by hanging or dusting panicles of the male flowers over the female flower clusters, just as they do to-day. On the earthen cylinders and tablets from the ancient civilizations of this region, the date-palm is depicted as the emblem of fertility, and the act of pollination given a religious significance. And even to-day, the Moorish Berber, in the sand-surrounded oases of Morocco, mutters an Arabic prayer as he performs this act. And of the date palm it is said there are over five thousand varieties. What an opportunity for adaptation—for new combinations better fitted to spread its kind!

In the slow-moving streams and shallow lakes of the northern hemisphere grows the eel grass, tape grass, or Vallisneria, a plant with the most romantic of all pollination stories. So romantic, that Maeterlinck has given a beautiful, fanciful, though essentially accurate account of it in "The Intelligence of the Flowers." So wonderful that even our prosaic botanists forget their usual language in describing it. Both the male and female plants pass most of their existence under water. At flowering time they both emerge for a short time. The female plant at this period, by a striking energy displayed in growth, sends up its bladder-enclosed flowers to the surface of the water, where the bladder-like buds burst, exposing the tripetalled flower with its densely fringed pistils. Here they float, until pollinated by the little boat-like male flowers loaded with a freight of sticky pollen, which throng the waters, floating helplessly (I almost said, but hopefully) about, waiting to fulfil their mission. In case they do not come in contact with the female flowers they die and are no more, for they, unlike the female flowers, at the time of their maturity beneath the waves, break all connection with their parent plant and shoot up to the surface. After pollination the female flower "already a mother, closes her corolla, in which lives their (the male flowers') last breath, rolls up her spiral (stalk) and descends to the depths, there to ripen the fruit of the heroic kiss."

In the well-known corn or maize, the male and female flowers occur in distinct clusters, but upon the same plant. You know them as the tassel and immature ear with its silks. Here, as in almost all the grasses, the wind is the great pollinizer. You would think that here inbreeding or self-pollination might often be the normal thing. But if you planted one stalk or even one row of corn by itself, the chances are you would get very few well-filled ears. Why? Because the pollen is not heavy enough to fall straight down, but descends in a more or less slanting direction, so that only a part of the silks of the same plant would be dusted with the pollen from its tassel. Then again, much of the pollen might be shed before the silks appear. And curiously enough, corn offspring from the same plant acting as father and mother, is not apt to be as robust or as prolific as those with two distinct plant parents.

Some flowers, or rather flower clusters, strictly speaking, have about as disgusting an odor as there is in all the range of scents. All lovers of wild things know the skunk cabbage and its fetid perfume. But it has many relations in the tropics with perfumes not differing in kind, but untold times more powerful. One of these is sometimes found in conservatories under the name of black calla lily, and on a hot day its fetid odor permeates the whole structure. One wonders perhaps why a plant exists with such a vile characteristic. But remember that plants are "looking out" for themselves and are quite oblivious to the tastes of human beings. This odor is an "at home" invitation to certain kinds of flies that revel in just this kind of an atmosphere. And these flies are invited to a nice, warm, barrel-shaped chamber in the base of the so-called flower—a chamber with a row of downward-pointing bristles for a gate, through which they easily enter, but through which they cannot make their exit until the flower has achieved its purpose. The food is plentiful, and after several days, when the pollen has been discharged and the flies have been dusted with it, the gate of bristles becomes limp, dries up, and they are at liberty to pass on to the next flower cluster, where they cannot help but dust its receptive pistils. To some of these arums, as the family is called, come numerous little flies or midges, and in one species the small visitors, after their usefulness as pollinators has passed, are entangled by the sticky hairs and digested by plant juices. Other flowers of this family attract more gaudy visitors—big green-gilded carrion flies, some of which even raise their families in the flower's odorous depths. Still other species attract the carrion beetles, as many as 250 individuals having been taken from one single spathe or "flower." One of these arums, living in southeastern Asia, attracts snails by an odor issuing from an entrance to the female flowers. The snails, already covered with pollen from other flowers, crawl through this door which soon closes, and do their Fate's appointed task of pollinating these female flowers. But the road they have traveled has a gruesome end, for after performing this service, the plant to protect itself against the flower-eating depredations of its servants, secretes a caustic poisonous liquid in which the snails die. As a student of natural selection, I have grave doubts about this tale. Through the centuries in which this tragedy has repeated itself, it would seem that the supply of snails thus tempted would have failed unless perhaps they take this journey in their old age after their days of procreation are past.

The sweet flag, or Calamus root, from which baby toothing things are made, also belongs to this family. In Europe, where it has been introduced, it never sets seed, due either to the absence of its American insect pollinators or to its self-sterile condition, it being claimed that all the European plants were propagated by division from one original plant. To this group also belongs the cousin of the so-called black calla, the Titan-flowered Amorphophallus with flowers nearly three feet wide and almost six feet long—a huge, dirty, yellow purplish cornucopia or flagon, from the depths of which the carrion odor permeates the dark Sumatran swamps for long distances, and in which the carrion flies buzz away in full contentment. This is probably the plant that has given rise to numerous superstitions of a flower with poisonous exhalations deadly to goats or dogs tied near it overnight and in the loathsome depths of which innumerable small birds and bats meet their end.

Plants of other families than the arums also possess fetid odors of various types. For example, Arnold's Rafflesia, a plant wholly parasitic on relatives of our grapes, producing a flower about 3 feet across, scents the Sumatran jungles with its loud perfume. On the South African deserts, the Stapelias, relatives of the milk-weeds, send forth their invitations to the numerous carrion loving flies. In America the many members of the Birthwort or Dutchman's Pipe family also perform in this manner. The flowers of these plants bear more or less resemblance to the huge pipes the Germans smoke, and in Central America, there is one species with flowers so large that children use them in play for caps. Their vile smell in some species attracts troupes of little midges which alight on the conveniently provided platform and journey through a long, dark, narrow passage way in search of that which to them smells so enticing. And they, like the midges of the arums, find themselves imprisoned, for the passage way is lined with inward pointing hairs, through which escape is impossible. But again, as in the arums, the chamber is warm and the food is plentiful. On the second or third day of their imprisonment, the stamens shed their pollen on the chamber floor and the restless insects feast upon and cover themselves with it, whereupon the hairs wither and they creep out, to enter another flower, which is ready to brush the pollen from their bodies with its sticky pistils.

In Australia, in the desert scrub, grows a low flowering shrub that some botanists suspect is cross-pollinated, not by an insect, nor by the wind, nor by birds, nor even by snails, but by that weird relic of the ancient past when the highest strata of animal society carried its young about papoose fashion—in other words, the kangaroo. You would not have been more surprised if I had said turtle or fish, would you? This strange plant has its flowers grouped around a cup, into which is secreted or dropped, not honey, but a liquid with a sour-milk odor. The male and female parts of the flowers are so arranged that only cross-pollination is possible, and it has been assumed that when kangaroos stick their snouts into the cup to drink the liquid, their snouts become dusted with pollen, part of which they leave on the mature pistils of the next flower group they stop to drink at.

But more remarkable still is the giant orchid of Madagascar, *Angraecum sesquipedale* with a nectar tube varying in length from one to two feet, concerning which Mr. Darwin speculated. There ought, he said, when he saw the flower and had examined it, to be a moth over there with a proboscis as long as this tube, for no insect without such a long sucking organ could possibly obtain the nectar at the base of the tube, and the flower would not be pollinated. Some years later Humboldt discovered just such a moth. The orchids have remarkable apparatuses designed for securing cross-pollination, but as these are often discussed and the literature is quite accessible, there is no need to go into it here. Suffice to say that anyone that is not interested in a plant that has an apparatus that will glue two bags of pollen packets securely to a nectar-hunting visitor's feet, forehead, eye or back and send along another sort of glue that serves to assist in glueing a packet to the pistil of the next flower the visitor enters—is—well—overfed with movie stuff or— hopeless.

Birds and bats, except for the humming birds, are rare agents in flower cross-pollination, but in South Africa exist the sun-birds—lovers of brown Melianthus honey. Melianthus produces so much honey that when you shake the flower clusters, it almost rains honey. The sun-birds, in sipping this honey from its cup-like receptacle, come in contact with the pollen sacks and their foreheads are dusted, so that the next flower they sip from is cross-pollinated.

As youngsters, we used to amuse ourselves with barberry flowers by touching their pollen sacks with a pin to see them "jump." And that is what happens when the bee or other nectar hunting insect comes along and sticks its tongue or feet into the flower. For the stamen stalk, or filament, is smeared with honey, and as soon as the bee touches it—out it jumps, hitting him on the forehead and covering that part of him with pollen, some of which he leaves on the stigma of the next flower he visits. This same sort of thing happens in the flowers of the prickly pear cactus and the mountain laurel.

Another thing I used to ponder over was why so many bugs, beetles and other insects were found on golden rod flowers at night, in the early morning, or on cloudy, damp fall days, especially as these were the times when I could go flower-gathering and I did not appreciate their association. And a few years ago, I found out—from a book, of course. Golden rods are warmer and drier flowers at such times—their temperature is actually higher than the surrounding atmosphere, and that of many other sorts of fall-blooming flowers. So they furnish these insects, which have no permanent home and lead a hobo existence, with food, and warm, dry shelters. In the morning a plentiful breakfast is ready, for during the night this plant discharges its mealy pollen. The beetles and bugs in feeding become dusted with it, and in journeying on to other plants bring about cross-pollination.

I wish I could go on and on telling you about this subject, it is so wonderful and so fascinating. If only the flowers and their insect servants were forty or fifty times larger so that you could not help, as you go about, noticing all these interesting things going on. You would be quite amazed at all you had missed. You certainly would be astonished at the giant bumble bee emerging from a flower of "butter and eggs" or toad flax with two great balls of yellow pollen attached to his forehead; or at that other kind of giant bee buzzing around with a double bag of milkweed pollen attached paper-clip fashion to his feet, together with half a dozen clips without the bags. You would watch with great anxiety the rifling of a box or two of Mimulus or monkey-flower pollen, wondering whether the bee could lift the lid all by himself. And then night, with its ghostly white flowers and great hovering honey-hunting moths! But they are too small —you want something big to be interesting—like an elephant for instance. Only the more striking interests you—such a curious sights as a lot of moths caught in the slits of a bunch of flowers, because they were after honey that was meant for a certain kind of bumble bee that knew the technique involved and gave proper return. This is what happens in the case of Physianthus flowers outside their South American home. And the moths never get loose either.

Every essay, we were taught, should have a climax, and so I have saved the two most interesting relationships between plants and insects for a "proper ending". These refer to a little moth and a tiny wasp. The former does its appointed task so well that the uninitiated would easily believe it had been trained for the job—and so it has—but not by man, but by the great trainer of us all—"The Struggle for Existence."

The yucca in one or another of its numerous species is a common ornamental plant in most city parks over the country. In the west and southwest Spanish bayonet is one of its common names, as are also bear-grass and soapweed. Its pendant bell-shaped flowers are creamy white, of the general lily family type, with a three-parted pistil and six stamens. The seed pods each contain about 200 seeds. The pistil is terminated by a little pocket. The flowers expand and remain wide open only one night. At the same time the yellow, not over plentiful, sticky pollen becomes accessible to visitors. So much for the stage and background. Now enter the actors in the persons of small yellowish white, metallic-sheened moths, Pronuba by name—*Pronuba yuccasella* in full. In the early dusk the female moths flutter about the yucca flowers, collecting pollen, not to eat, but of which they make a ball, which they carry tucked up under their head like a huge crop, by an organ reminding one of a miniature elephant's trunk. This ball of pollen is often two or three times the size of the insect's head. The moth darts off to another flower with its ball and lays its eggs in the tissue of the pistil base, and stuffs the ball of pollen into the pistil pocket, all the time moving its head to and fro. In five days or so the eggs hatch, and in a few weeks the grubs have eaten their allotment of 18 or 20 partly mature seeds, have made a hole through the immature yucca fruit, let themselves to the ground by a thread, burrowed into the ground and spun their cocoon. When the yuccas bloom again, they appear as moths, once more ready for the performance. When these moths are absent, as often happens in ornamental plantations or botanic gardens, no seeds or yucca fruits are formed as the yucca cannot pollinate itself and no other moths or insects seem to be able to perform the act.

Although one of the most anciently cultivated fruits, man still has much to learn about figs. When the Smyrna fig was introduced into California the American fig-growers laughed at the "book stories" of the relation between this type of fig and the part the tiny capri-fig wasp played in making the trees bear. "Oriental superstition," however, turned out to be based on hard, solid act, and now "caprification" is practiced in California among growers of this type of fig with the same zeal that the Syrians have shown for centuries. The fig is not a fruit developed from a single flower, as most of our fruits are, but the result of an aggregation of hundreds of flowers. And these flowers which are all female, form the inner lining, so to speak, of a pear-shaped bag. All the cultivated varieties of fig bear only female flowers, while both male and female flowers are found on the capri or so-called wild fig. All the common or Adriatic figs develop "good figs" without pollination, but there are no fertile seeds. The Smyrna type of fig absolutely requires pollination to bring it to maturity, and since there are no male flowers on these trees, the pollen must be brought from the capri-fig trees. Obviously the wind cannot pollinate the bag-enclosed female flowers, nor could man. But associated with the capri-fig is a little wasp, the female of which, heavily dusted with pollen, crawls out of the capri-fig fruit and flies away to deposit her eggs. In so doing, she enters the Smyrna fig through a small almost scale-covered hole in the end of the immature fig, wanders around, incidently pollinating the receptive pistils of the female flowers, which later develop seed. These seeds are responsible in part for the superior quality of the Smyrna fruit. She is unable to lay her eggs because the pistils are too long for her egg laying apparatus. She soon dies without having left any progeny, which is fortunate, for if eggs had been laid, the Smyrna figs would be largely insects instead of fruit. Her race is continued, however, by those of her species which lay their eggs in the wild or capri-figs. In practise, capri-figs are planted at the rate of two or three trees to the acre, and the fruit containing the wasps is distributed in various ways through the orchards to each Smyrna fig tree.

If one is more technically interested in this subject, "The Fertilisation of Flowers" by Herman Müller, translated into English by D'Arcy W. Thompson, is a good book to read. "The Natural History of Plants" by A. Kerner and F. W. Oliver also contains much information on this subject, graphically described and in most cases, essentially accurate.

Further, some of the beds of the Ecological Section in the Brooklyn Botanic Garden, are arranged as a living demonstration of the pollination phases of plant life. Here you will find the yucca and its moths, the milk-weeds, and various other insect pollinated plants, as well as those which depend on wind. This section is opposite the Rock Garden.

ORLAND E. WHITE

NOTICES

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays at 10 a m. The Laboratory Building, containing the library, herbarium, and offices, is open daily (except Sundays), from 9 a. m. until 5 p. m. (Saturdays, 9–12). The Conservatories are open April 1–October 1, 10 a. m.–4:30 p. m. (Sundays, 2-4:30); October 1–April 1, 10 a. m.–4 p. m. (Sundays, 2-4).

The Garden may be reached by Flatbush Avenue trolley to Malbone Street (Empire Boulevard); Franklin Avenue and Lorimer Street trolleys to Washington Avenue; St. John's Place trolley to Sterling Place; Ninth Avenue, Union Street, Vanderbilt Avenue, and Smith Street trolleys to Prospect Park Plaza and Union Street, and Brighton Beach Express, Broadway (B.R.T.) Subway, to Prospect Park Station, north exit.

A docent will meet parties by appointment and conduct them through the Garden. This service is free to members of the Botanic Garden and to teachers with classes; to others there is a nominal charge of 25 cents an hour for parties of less than three, and 10 cents a person per hour for parties of three or more.

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BROOKLYN BOTANIC GARDEN

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TIME AND SUNDIALS

On the sundial in the garden,
The great sun keeps the time;
A faint, small, moving shadow,
And we know the worlds are in rhyme.
But if once that shadow should falter
By the space of a child's eyelash,
The seas would devour the mountains,
And the stars together crash.
—R. W. GILDER.

In the spring of 1920 there was installed in the children's garden a sundial, presented by the 1914 graduates of the garden teachers' course, with a shaft presented by the graduates of 1919. For centuries before clocks were invented sundials were used. The inscription "I count only sunny hours" is often found on sundials. When the sun shines, time is indicated by a shadow on the dial, marked off to correspond with the hours.

The essential point about a sundial is that the part throwing the shadow, the *gnomon*, must be parallel to the axis of the earth. That is, at any place the gnomon must be at an angle equal to the latitude. If the North Pole were really a pole projecting above the surface it would make an ideal sundial; that is for the half-year during which the sun is there above the horizon. At any time the shadow of the pole would point to the part of the earth which has midnight, the place under the sun having noon, as shown in Fig. 1.

The simplest form of sundial is one in which the dial face is slanting, so as to be perpendicular to the earth's axis. This practically reproduces the North Pole condition at any place. A central rod, parallel to the earth's axis, throws the shadow. However, with this form of dial during the six winter months the sun would shine on the *under* side, that is during the time the sun shines on the south pole.

In the ordinary horizontal sundial the dial face is parallel to the plane of the horizon, or to the surface of still water. It is in fact a "North Pole dial" projected at an angle. Thus the East and West spaces become larger than those near the noon mark. Speaking more exactly, North and South lines would be lengthened in proportion to the secant of the latitude. In making a

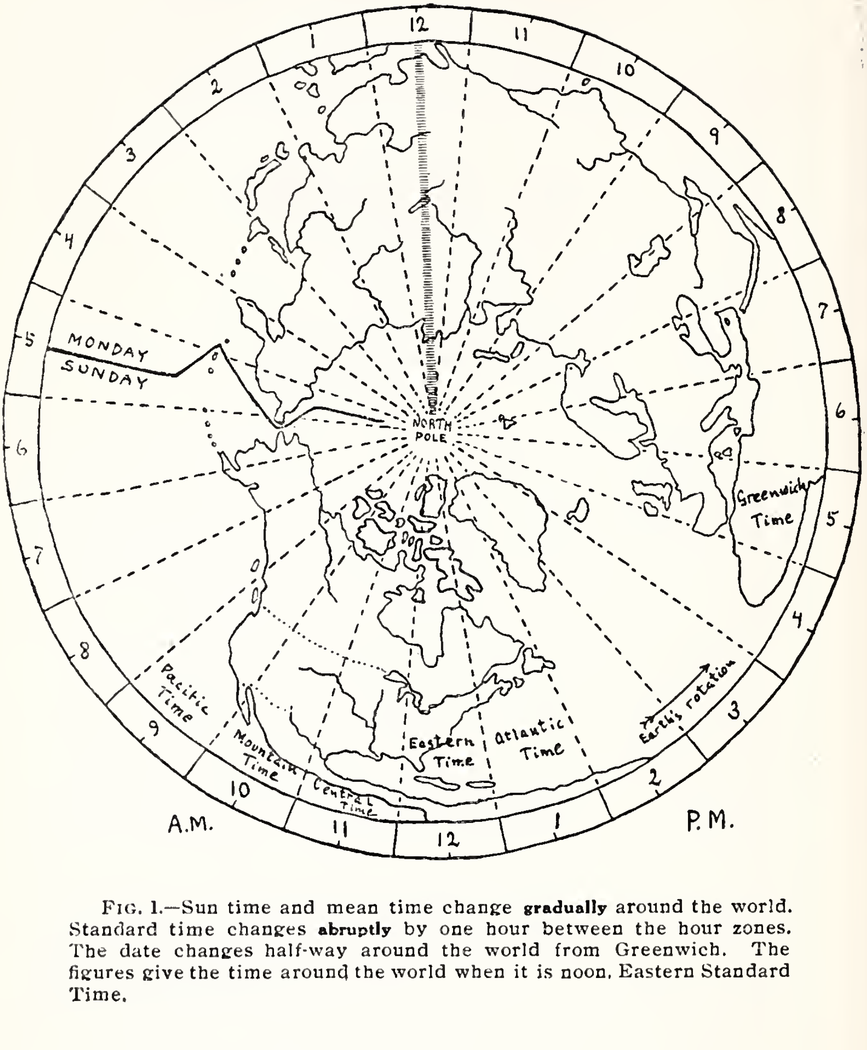

FIG. 1.—Sun time and mean time change **gradually** around the world. Standard time changes **abruptly** by one hour between the hour zones. The date changes half-way around the world from Greenwich. The figures give the time around the world when it is noon, Eastern Standard Time.

sundial a simple way to get the hour marks is by timing the sun's shadow with a watch.

To set up a sundial, or to read it accurately one must know the difference between sun time and clock time. The amount and direction of this difference varies through the year as shown in Fig. 2. If, for example, on May 15 the sundial reads say 10:30, standard time is 9 minutes slower, or 10:21, daylight saving time would be 11:21. In the middle of February the sundial is about 10 minutes slow (in Brooklyn), in the beginning of November 20 minutes fast.

To apply this correction it is not necessary to understand the reason for the varying of sun time. The reason is interesting, though somewhat complicated. We must consider first the daily then the more difficult annual motion of the earth.

Due to the earth's rotation from West to East, the sun appears to move from East to West. The shadow of any object travels from West to East. The daily motion of the earth is uniform, but the position of the shadow depends not only on the earth's daily rotation but also on its yearly motion (revolution) around the sun. Since there are 365 days approximately in a year, the earth must turn on its axis every day 1/365 part of a circle more than one rotation to "catch up" with the sun. In fact, one rotation takes only about 23 hours 56 minutes, the additional four minutes are required for any given place to reach the same position it had the day before with respect to the sun.

Now, the earth's motion around the sun is slightly irregular, for two reasons with rather long names. The first is the *eccentricity of the orbit*, which means that the earth moves, not in a circle, but in an ellipse, with the sun at one of the foci. When nearest the sun (which happens to be in January), the earth moves faster in its orbit. So it takes a few seconds longer before the sun is directly south again, casting a shadow due north. Thus the sundial is slow, and this difference increases (i. e. is cumulative) from day to day. When the earth is at an average (or mean) distance from the sun, in spring and fall this difference is zero.

The second irregularity is caused by the *obliquity of the ecliptic*, or plane of the earth's orbit. Only in June, when the days are longest, and in December when they are shortest (summer and winter solstice) is the line of the earth's motion perpendicular to the earth's axis. During spring and fall the earth moves at an angle to the plane of the equator. Thus its motion perpendicular to the earth's axis is slower. That is, considering this cause alone, the actual duration of a day, or the interval between the time the sun is in the south two successive days, is long in summer and winter, short in spring and fall, and the sundial movement is correspondingly affected. Four times a year there is no correction from this cause.

These two irregularities combine to make the curve of Fig. 2. Sun time, also called apparent time, is the *real* time by the sun.

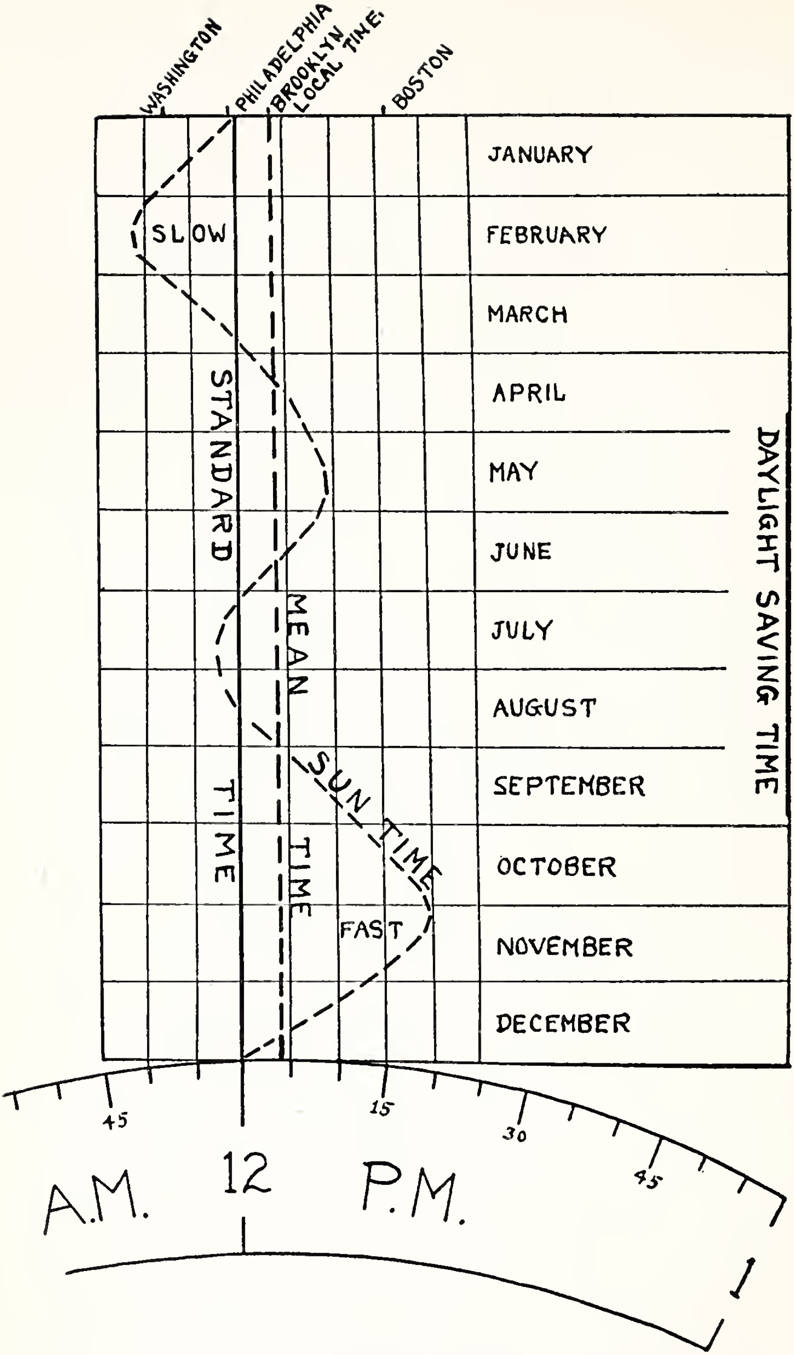

Fig. 2.—Relation of four kinds of time in the longitude of Brooklyn. For other longitudes the dotted lines should be moved to the left or right. Sun time is equal to mean time April 16, June 15, September 1, and December 25.

When the sun is due south (in the northern hemisphere), it is always 12 o'clock sun time.

However, for practical purposes it is desirable that days should be of equal length. So uniform time is not sun time, but is measured by an imaginary or *mean sun* which corresponds to the real sun only four times a year. The mean sun gives *mean* or local time.

Since the earth rotates on its axis from West to East, mean time varies, going East and West. As one travels West his watch becomes too fast since he is travelling ahead of the sun. He must either stop his watch until the sun catches up, or else set his watch back. *Standard time* is the mean time of a certain longtitude, or standard meridian; it is the actual time shown by clocks. In the Eastern United States the standard meridian, which is 75 degrees west of Greenwich, passes just east of Philadelphia. Now Brooklyn lies on 74 degrees west longitude. Therefore the sun is south in Brooklyn four minutes earlier than in Philadelphia, since the sun requires four minutes to travel westward over one degree of longitude.

Finally, *daylight saving time*, when used, is one hour faster than standard time. Under daylight saving time 12 o'clock standard time is called 1 o'clock. It is determined arbitrarily, by law.

The diagram (Fig. 2) indicates the differences between the four kinds of time: Sun time, Mean time, Standard time, and Daylight Saving time. It will be seen that in Brooklyn, during July and most of August, the sundial shows standard time within two minutes, that is, it is practically "correct."

With an understanding of the relation of sun time to standard time, a sundial properly made and set up should show time within two minutes. This is the width of the penumbra, or half-shadow, two minutes being the time required for the sun to pass over its own diameter. Once securely set up a sundial indicates the time from year to year unchanged.

A. GUNDERSEN.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES IX BROOKLYN, N.Y., JUNE 15, 1921. No. 6

JOHN BURROUGHS

TEACHER, POET AND NATURALIST

> "O Papalagi, I say, your people looker beyond the mountains at the stars for the wisdom of the great waters, when 'tis only to be heard in the sweet-toned shells that are scattered on the sunny shores of childhood."—O LE LANGI.

John Burroughs has journeyed past the last earthly milepost. Physically he is no more among us. Spiritually he will live forever, for he was of the breed of Thoreau, Emerson and Gilbert White of Selborne. He possessed the rare power of making the commonplace nature life in the midst of our civilization wonderful and fascinating. Through his eyes we were taught to see that our near-at-hand wild life is just as marvellous as that of some far off tropical land. He was an explorer of the agricultural wilderness. He told us in an understandable way the story of the mountains, the fields, the seasons and the wild life that we meet with every day in our civilized populous communities. "The longer I live the more my mind dwells upon the beauty and wonder of the world. I hardly know which feeling leads, wonderment or admiration." Thus he writes in "The Summit of the Years." As with the old pagan Samoan poet, O Le Langi, of whom Safroni-Middleton writes, John Burroughs listened with the ears of a child, and never ceased his wonderment at Nature's ways. He never became a dry, sophisticated scientist. His discoveries of the ways of birds and of woodchucks, of squirrels and of wild flowers always gave him the thrill of the explorer in the unknown wilderness. His success is Thoreau's "If the day and night are such that you greet them with joy, and life emits a fragrance like flowers and sweet-scented herbs, is more starry, more immortal,—that is your success. All nature is your congratulation and you have cause to momentarily bless yourself." The song of the hermit thrush meant more to him than the songs of the great opera singers in the "crowded lives of men." "I have loved the feel of the grass under my feet, and the sound of the running streams by my side," he writes. And again, "The hum of the wind in the tree-tops has always been good music to me, and the face of the fields has often comforted me more than the faces of men." "The youth enjoys what the man tries to understand. Lucky is he who can get his grapes to market and keep the bloom upon them, who can carry some of the freshness and eagerness and simplicity of youth into his later years, who can have a boy's heart below a man's head." And John Burroughs' grapes always arrived at market with the bloom intact.

But perhaps you wonder what manner of man this was, how he lived, what his associates were, and what one thought who was privileged to have seen him at his own fireside. His life has often been recited in the public prints. His writings, both from a literary and a scientific standpoint, have stood the fire of the critics.

To me, John Burroughs was a boyhood hero,—a hero I hesitated ever to see in flesh and blood, because a boy's heroes often come down from their high pedestals when viewed through the mature eyes of the grown man. I knew him when I was a child—a child who was a lonesome, natural history loving farm boy in South Dakota. He became my friend through a copy of "Fresh Fields," wherein I read his experiences in England in his efforts to hear the nightingale's song. I wrote him; he answered. The great naturalist encouraged me to believe that some day I too might become a writer—that I too might express myself interestingly about the things I saw and the thoughts I thought. That episode, perhaps more than any other outside influence, determined my choice of a life work. I would write some day about the wild life of the Dakotas—I would make the mourning doves among the fluttering cottonwood leaves sing their mournful coo for the whole world. The rosy-breasted gulls wheeling in circles over the ploughboy's head would be pictured in black type, so that they would live for all and forever. I kept a journal. Its pages are full of the blooming of flowers, of the hatching of grasshopper's eggs, of wild geese travelling north and south, and of the doings of beetles. Years passed. I found myself a grown man—at the beginning of a scientific career. Often I looked back over the years, wondering what influences had served to mold me. I thought again and again of Burroughs, of his books and of his kind, encouraging letter. I thought of Walden, my sacred book, and how I had come to read it. I came east. I often planned to visit "Slabsides" and West Park. Could I risk it? Should I see him. Through a friend's insistence, one drizzly afternoon I found myself before my hero. We talked through the afternoon,—four of us—my friend and I, and Dr. Barrus and John Burroughs, and later dined together. He told me he would rather have been the author of "Walden" than of any other book he knew. We parted on the roadway to which John Burroughs had insisted on lighting us. And my friend said, "Well, White, he *was* real, *wasn't* he?" And he was—one of the most unaffected, natural, sincere men I have ever met. A man to whom the song of a thrush made a full and happy birthday. His life was marked by great simplicity. Much of his writing was done on an improvised desk made of boxes and a chair of the same crude type. Thus provided, he sat in the doorway of his ancestral hay barn at Woodchuck Lodge in the Catskills, dreaming and writing away the long summer days. From his rustic writing seat, he looked across a little pastoral mountain valley. Around him the birds sang, the chipmunks gamboled and the woodchucks whistled.

In his little, plain study at West Park the fireplace mantel had a picture of Walt Whitman on one side, and a print of Mona Lisa on the other. I often wondered what brought these two together in John Burrough's mind, but he was gone before I had asked him.

His "Slabsides" study was also rustic and simple. And his desire for a simple life and surroundings was an integral part of him—no pose, no fad, no fancy. In the midst of famous men and women, he, their undoubted peer, was the least conspicuous, and at eighty-three, his last birthday, he was as young in mind as a youth. He loved men and women for themselves. Wealth and worldly position meant nothing to him in his friendships. And he died as he lived—no ostentation, no pomp and ceremony—no reading of letters from foreign academies and foreign ambassadors. Just a grave on his beloved mountain side, and a few friends and neighbours.

"In every man's life we may read some lesson. What may be read in mine? If I myself see correctly, it is this: that one may have a happy and not altogether useless life on cheap and easy terms; that the essential things are always near at hand; that one's own door opens upon the wealth of heaven and earth; and that all things are ready to serve and cheer one."—"The Summit of the Years."

I have tried, gentle reader, to picture him to you as he appeared to me.

Orland E. White.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES IX BROOKLYN, N.Y., OCTOBER 5, 1921. No. 7

HOUSE PLANTS*

It is well to recognise that many difficulties have to be faced before plants can be grown successfully in an ordinary dwelling house, but, by giving careful attention to cultural details these can often be overcome. The hot, dry atmosphere, the fumes of illuminating gas, insufficient light, and great variation in day and night temperature, all tend to make their cultivation a difficult operation. However, in spite of these drawbacks, it is possible to grow quite a variety of plants in an ordinary house, and one need not be limited to the ubiquitous India rubber plant. It is among the so-called "foliage" plants that the greatest number of suitable subjects for the purpose under consideration are to be found. The Boston ferns, dracaenas, pandanus, aspidistra, and sanseviera are well adapted to withstand adverse conditions. In selecting flowering plants, those should be chosen, as far as possible, which make a large part of their growth out of doors. Among this class of plants are the forcing bulbs, such as hyacinths, tulips, crocus, and the well-known azaleas. Primroses and cyclamen will also last quite a long time in good condition.

The best aspect for the majority of plants is in a window facing south or southwest, as there are comparatively few plants that will grow satisfactorily without abundance of light. If a well-lighted position is not available, one's choice is almost entirely restricted to foliage plants. A bay window on the sunny side of a house will provide almost ideal conditions for quite a number of plants, and a delightful effect may be obtained either by growing them in pots or in boxes constructed to fit the window.

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* This leaflet is a revised reprint of Number 12, Series III.

Temperature is an important factor in the successful cultivation of plants, and violent fluctuations should be avoided as far as possible. If warmth-loving plants are grown in a room which is unheated at night, as often happens, they should be protected in some way during severe weather. This may be done by removing them to a heated room or away from the windows. If this is impossible, they can be protected by covering them at night with paper or other non-conducting material. Bound up with the question of temperature is that of ventilation. Plants object to impure air as much, or more, than human beings; therefore, the room in which they are grown should be ventilated whenever possible, taking care, however, that cold drafts do not blow directly on the plants.

One is frequently asked, "How often must I water my plants?" To this one is compelled to reply, "As often as they need it." There can be no fixed rule as to the quantity and frequency of the application of water to plants; so much depends upon the humidity of the room in which the plants are growing, the nature of the plant, and the capacity of its roots to absorb water. Whenever watering is done it should be done thoroughly, so that the earth is wet all through. No further watering is needed until the earth shows signs of drying out, when another application should be given. Thorough watering is most important, otherwise the earth on the surface of the pot may have the appearance of being moist, while an inch or so below the surface it may be dust dry, greatly to the detriment of the plant.

Those living in a city often have difficulty in obtaining a supply of suitable soil for potting purposes, and the best plan in such cases is to obtain soil ready mixed from a florist. The best kind of soil for the majority of house plants is that formed of loam cut from the surface of a meadow, pasture or lawn. This should be mixed with stable manure in the proportion of three parts of soil to one part of manure, piled in a heap, and left for a year or so in order that the grass roots and manure may decay. Using this as a base, by the addition of leaf mould, peat, or sand, for such plants as need it, we have a soil that makes a suitable potting medium for almost any class of plants.

No definite rule can be laid down as to when plants should be repotted. If they are making vigorous root growth this may be done at almost any time, but, as a general rule, repotting is best done in early spring, just before the plants begin their new growth. Repotting into a larger pot should only be done when the pot is crowded with roots, otherwise harm rather than good will result; indeed much of the unhealthiness in house plants can be traced directly to attempting to grow them in too large a pot. It sometimes happens that repotting is necessary because there are too *few* roots in the pot rather than too many. This occurs when, through overwatering, the earth becomes sour, and, as a consequence, the roots are unable to maintain themselves in a healthy condition. Plants in this condition should have the soil gently washed from the roots previous to repotting them in fresh, sweet soil. Use pots large enough to contain the roots without crowding them. The new pots should be washed clean and allowed to dry before using. Proper drainage is very important in order that superfluous water may be readily carried off, and this is best obtained by placing a layer of broken pots or coarse ashes over the bottom of the pot. When repotting into a larger pot, the plant should be turned out of the old pot, placed in position and earth filled in around it, tamping the earth down with a piece of lath or something similar, in order that it may come uniformly in firm contact with the roots. Care must be taken not to pot the plant too deeply; the old ball of earth should be covered with about one-fourth inch of soil.

Owing to lack of facilities for syringing, plants in dwelling houses rapidly become coated with a layer of dust, and this must be removed if they are to be kept in good health. Those plants having large, leathery leaves are best dealt with by washing; using a soft sponge and tepid soapy water. This process is too tedious an operation in the case of ferns and plants having small leaves, which should be washed by spraying them with water from the faucet or garden hose. Advantage should be taken of warm gentle rain by placing the plants out-of-doors, as they are greatly benefited by this process.

The insects most likely to infest house plants are aphids, mealy-bug, scale, and red spider. Aphids can easily be exterminated by spraying, or by dipping them in a nicotine solution; or an insecticide can be made by dissolving ordinary soap in water at the rate of one pound of soap to eight gallons of water. Scale and mealy-bug are more difficult to dispose of. The surest way is to wash them off with a sponge and soapy water; if this is impracticable, kerosene emulsion or one of the proprietary insecticides, used as a spray or dip, will, if persevered in, ultimately dispose of them. Red spider flourishes in a warm, dry atmosphere such as is usually found in living rooms, and if it once obtains a footing it is extremely difficult to control. Washing, as in the case of mealy-bug, is the best remedy; failing this, the under sides of the leaves should be sprayed with water with sufficient force to dislodge the insects.

All house plants are benefited by being placed out-of-doors during the warm summer months. This is especially true of azaleas, which should be placed in a partially shaded position outside as soon as danger of frost is over. All pot plants when grown out-of-doors should have their pots plunged to the rim in earth or ashes, as this helps to prevent the soil from drying out too rapidly, and also effects a saving of labor so far as watering is concerned.

Following is a list of plants that, given reasonable care, will thrive under house conditions:

FOLIAGE PLANTS

Scientific names	Common names	Remarks
Araucaria excelsa	Norfolk Island Pine	
Asparagus plumosus	Asparagus Fern	
Aspidistra lurida	Parlor Palm	
Begonia Rex	Rex Begonia	
Cocos Weddelliana	Weddell's Cocos	All palms delight in a well drained rich soil and abundant moisture
Cyperus alternifolius	Umbrella Plant	Pot should be kept partially submerged in water
Dracaena Godseffiana	Gold-dust Dracaena	
Dracaena indivisa	Fountain Plant	
Ficus elastica	India Rubber Plant	
Ficus repens	Creeping Fig	Trailer
Hedera Helix	English Ivy	Trailer—good for growing in shade
Kentia Belmoreana	Curly Palm	
Kentia Fosteriana	Thatch-Leaf Palm	
Nephrolepis exaltata bostoniensis and many varieties	Boston Ferns	
Pandanus utilis	Screw Pine	
Saxifraga sarmentosa	Mother of Thousands	Trailer
Tradescantia (several species)	Wandering Jew	Trailer

FLOWERING PLANTS

Azalea indica	Indian Azalea	Likes peaty soil
Begonia argenteo-guttata		Begonias grow best in a compost containing a good proportion of leaf soil
Begonia semperflorens	Ever-flowering Begonia	
Begonia Thurstoni	Thurston's Begonia	
Camellia japonica	Camellia	Likes peaty soil
Cyclamen		
Epiphyllum truncatum	Christmas Cactus	Use rather poor soil
Impatiens Sultani	Zanzibar Balsam	
Pelargonium domesticum	Lady Washington Geranium	
Pelargonium zonale	Zonal Geranium	
Phyllocactus vars.		
Primula sinensis	Chinese Primrose	
Richardia africana	Calla Lily	Needs rich soil and abundance of water
Bulbs in great variety		

Except where otherwise specified, loam, with a small proportion of decayed manure, should be used as potting soil.

MONTAGUE FREE.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES IX BROOKLYN, N.Y., OCTOBER 19, 1921. NO. 8

THE COLLECTION OF WATER LILIES AT THE BROOKLYN BOTANIC GARDEN

This year the display of water lilies in the out-door conservatory pools has proved one of our greatest attractions, vying in popularity with the Japanese garden, although the latter will probably always take first rank as the people's favorite. The conservatory plaza, with its lily pools and gardens, was one of Mr. Alfred T. White's last gifts to the plant lovers of Brooklyn. This is its second year in operation.

It is partly because this feature is so recent a development of the Garden that we wish to call attention to it in this Leaflet. Of the two pools, the one towards the north is devoted to tropical lilies, comprising several species and beautiful hybrids—the latter, with their soft shades of blue and carmine, a triumph of the plant breeder's art. The south pool contains hardy species and hybrids related to our own white water lily and to its first cousin, the European water lily.

All lovers of these plants should visit these pools now while the tropical varieties are still in bloom. Water lilies manifest great variation as regards the time of opening their flowers, some being classed as night blooming and others as day blooming. The best time to catch both sorts in bloom is between eleven and twelve of a sunny morning, for between these hours the day bloomers have opened up and the night bloomers are not yet closed.

Perhaps the most interesting plant of all is the Royal Water lily, *Victoria Cruziana*, near the north end of the north pool. It is easily recognized by its curiously shaped leaves, resembling with marvelous accuracy a huge round tray, with a narrow, erect rim, slightly curved inward, and the whole set flat upon the water, hence sometimes known as the Giant Water Platter. Another name given to it in South America is "Water Maize," or "Water Corn," for the seeds are gathered and eaten by the natives. The leaves sometimes attain a diameter of seven to eight feet, and then have been shown to be capable of supporting a man's weight, after a light platform has been placed upon them to equalize the pressure on all parts of the leaf. Unlike the leaves of other plants these are perforated with countless tiny holes through which any water from rain or other sources passes, and through which, also, gases rising through the water beneath may find egress into the air above. Moreover, if these holes did not exist, a leaf with such a tray form would collect rain water where the growth of various algae and fungi would doubtless hinder the leaf in its food making processes.

The flowers, in our plant from 8 to 10 inches in diameter, are nocturnal and last for two days. They open slowly in the evening; the following morning the outermost whorl of creamy white petals is unfolded, and throughout this day additional whorls of petals unfold until by evening the center of the flower is exposed. When the last whorls of petals appear, a distinct rosy hue is noticeable at their bases, and by the following morning the whole flower is suffused a deep rose or pink, and by a twist in the stalk has been drawn partly under water. The flower is said to be very fragrant, giving off a sweet, pineapple odor. Our plant has bloomed four times: five more buds are in various stages of development. The Royal Water Lily is a native of South America, where two forms are known: *Victoria regia*, growing from British Guiana south to the Amazon and its tributaries; and *V. Cruziana*, which flourishes In the region of the Parana river and its tributaries in Paraguay. The two forms apparently grade into one another where the tributaries of the Parana and Amazon interlace. The plant was noticed by Haeneke in Bolivia about 1801, but the first published description did not appear until 1832, under the name of *Euryale amazonica*. Finally Dr. Lindley established the genus in 1837 in honor of Queen Victoria. For many years unsuccessful attempts were made to raise *Victoria regia* in England, but *V. Cruziana* proved more amenable to cultivation, particularly in America, being a hardier form. Nevertheless the cultivation even of this form is attended with difficulties, since it is necessary to start the seedlings in the greenhouse and later to heat the water of the pool artificially during the spring months.

At the other end of the pool is a specimen of *Euryale ferox*, a first cousin of Victoria, but a native of India. In the region of Bengal it is cultivated for its seeds, which are baked and eaten by the natives. Before the discovery of *Victoria* this was considered to be the handsomest of all aquatic plants in regard to size of leaves, which indeed resemble those of *Victoria*, but are without the upturned rims. However, its small purple flowers are disappointing, for one expects something larger and more striking from such exuberant foliage.

The remainder of the north pool is occupied by horticultural varieties or by species of tropical *Nymphaeas*, which are of exceptional beauty. At the north end, near the *Victoria*, may be seen a small flowered form of *Nymphaea gigantea*, a native of Australia, with rounded petals of a rich purple hue. This plant was raised here in the Brooklyn Botanic Garden from seed obtained from the Botanic Garden at Buitenzorg, Java. One of the most striking of the Nymphaeas is *N. devoniensis* in the center of the pool, with its profuse display of rose colored flowers. The "blood" of the ancient Egyptian Lotus (*Nymphaea Lotus*) and the Indian *Nymphaea rubra* is said to be comingled in this plant, although there is some doubt as to the identity of the former parent. This plant is one of the night bloomers. During the month of September it has commenced to open about seven in the evening on a clear day, and by eight o'clock the flowers are fully expanded. By noon of the following day its flowers are completely closed.

Nymphaea Bisseti is another beautiful night bloomer at the northwest corner of the north pool. When fully open it measures from eight to ten inches in diameter, with petals of a beautiful rose color, the outermost of a somewhat deeper shade. In the month of September it begins to open about six o'clock and by eight o'clock in the evening it is fully open. By noon of the following day it has again closed. The majority of the other forms in this pool are day bloomers.

From a morphological point of view the leaves of some of these hybrids, e.g. *N. Daubeniana* in the southeast corner, are interesting in that they exhibit a remarkable reproductive power, comparatively rare in leaves in general. Just at the point where the leafstalk joins the blade, a new plant forms, with roots, a short stem, and even flower buds. The cultivator experiences no difficulty in rapidly increasing his stock of the varieties that exhibit this peculiarity.

The south pool, as already noted, contains our own native white water lily and the common European species, although the form of European lily growing at the northwest corner of the pool is a horticultural variety. All the forms in this pool are more or less closely related to these two species, and one may see at a glance that they form an entirely different group from those in the north pool. Many of the beautiful hybrids here were originated by the famous French plant breeder, Latour-Marliac, from 1888 to 1900. His methods, according to Bailey's "Encyclopaedia of Horticulture," remain a mystery. They are all hardy and perennial, while those of the north pool must be reset from year to year. Although they lack the rare exotic loveliness of the tropical forms they nevertheless have a modest beauty of their own. At the south end of the pool may be found two forms of *Nelumbo* which are now through flowering, and are holding their fruits high in the air in their characteristic manner. *Nelumbo lutea* is the American species, with sulphur yellow flowers, while *N. alba grandiflora* is a horticultural variety of the East Indian Lotus with large white flowers.

If the visitor is interested in the Lotus he should by all means see the vigorous colony of East Indian Lotus, *Nelumbo nucifera*, in the lake by the Japanese Garden. A few examples of its enormous pink blooms are still with us even at this late date, but its most prominent features at present are the striking seed pods, their perforated tops reminding one somewhat of gigantic salt shakers. These pods have great decorative value and may be seen artificially colored, in florists' stores associated with other dried plant forms as members of so-called "everlasting" bouquets. This whole colony of *Nelumbo*, originally planted in a box about four feet square, last year escaped from the box. The large area it now occupies would seem mute testimony that the Brooklyn environment compares favorably with its East Indian home.

The writer has been particularly interested in the opening and closing of the water lilies. What is its cause? What are the mechanisms involved? Why do some sorts open at night and others in the daytime? These are problems which in part still await solution, and would furnish an interesting topic for investigation. Conrad,* in his monograph on the water-lily, says, "We must conclude, therefore, that light is . . . the principal stimulus, causing in these closure, in other species opening of the flower. The difference in effect is paralleled in positive and negative heliotropism and positive and negative geotropism."

Of course the *immediate* cause of the opening of the petals is the increase in size of the cells on the inner or upper face of the petal, thus making the total upper surface greater than the under and therefore curving the petal outward from the centre of the flower. Conversely the closing of the flower must necessarily be due to the increase in size of the cells on the outer or under surface of the petals causing it to become greater in extent than the inner surface and resulting therefore in a curvature toward the centre, or closing of the flower. And accompanying this increase of cells on one side, there may be a shrinkage of those on the other.

But to what is this variation in the size of the cells due? It is evidently the result either of unequal growth of upper and under surfaces, in which case the flower may be continually getting larger day by day, although perhaps imperceptibly so; or it may be caused by daily difference in turgescence of the surface tissues on upper and under surfaces, in which case no growth of the flower would necessarily occur.

And as to the cause of these differences in the rate of growth† or of turgescence of the cells we come finally to light as the stimulating factor, which as Conrad states, operates differently in in different species, a phenomenon which has a direct parallel in the opposite effect which gravity, for example, has on root and shoot of an ordinary plant.

ARTHUR H. GRAVES.

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* Conrad, H. S. The Waterlilies. A Monograph of the Genus Nymphaea. Carnegie Inst. of Wash., Pub. 4, 1905, p. 120.

† According to a recent authority, growth in plants is essentially the hydration of colloids in the cell accompanied by metabolic changes necessary to the formation of new living matter, a process to which materials in the cell sap contribute.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES IX BROOKLYN, N.Y., OCTOBER 26, 1921. NO. 9

PLANT IMMIGRANTS AND NATIVES: A COMPARISON

"America's Making," a festival and exhibit of three centuries of immigrant contributions to our national life, is now in progress in the local schools. Its purpose is to show, in popular form, the most important historical, economic, and cultural contributions that Americans of various lines of racial descent have made to the American nation, including agriculture and industry, arts and crafts, architecture, folklore, literature, drama, music, and education. In connection with this festival, the Brooklyn Botanic Garden has placed on exhibit, from October 15 to 28, specimens of the more familiar plants of the local flora in two groups: 1. Those strictly native to North America; 2. Those introduced from foreign countries—*i.e.* plant immigrants. The exhibit also includes introduced plants of economic importance, with an indication of the country to which we are indebted for their introduction. The present LEAFLET is issued in connection with this exhibit.

Into the making of America so many races have entered that few among us have any true idea of the characteristics of even a handful of the nationalities that comprise the metropolis. Foreign born people in Greater New York total 34 per cent of the population, and of the 66 per cent remaining none is truly 100 per cent American, for the last of our local native Indians passed away years ago.

Whether foreign born in the present generation or in one or two preceding, all of us have to work together, fitting our individual plans and schemes into those greater plans that have made America what it is. Upon the willingness of the individual to do this depends the life of our great democracy, and upon the willingness and ability of the newcomers among us to bear their part depends the future.

Few of these newcomers, and certainly not many of the older inheritors of the privileges and responsibilities of America, realize that the plant population which paints our countryside with such a gorgeous panorama of vegetation has also a curiously mixed ancestry. For, just as in human communities there are elements of diversity, so in the plant population near New York there is a curious mixture of different races and strains. Unlike any of the residents of New York, many of our local plants are truly American, for they have always been here, at least since the retreat of the continental ice sheet many thousands of years ago. Some doubtless, originated here. Others, like the people, have come from the four corners of the earth, and perhaps, "like the people, because it is the fashion."

Let us look for a moment at the main features of this plant population of the vicinity of New York, for it is interesting and beautiful on its own account. Perchance it also holds some lesson for immigrants and native born Americans alike.

The total number of different kinds of flowering plants and ferns known to grow without cultivation hereabouts is 2,651, of which something like twenty-three per cent are trees, twenty-nine per cent shrubs, and all the rest are herbs, which, of course, comprise all the wild flowers beloved by nature trampers. Of these 2,651 *species*, as the different kinds are called, 613 are not truly American plants at all, but have been introduced from other countries, usually without the knowledge of those who brought them. Some of these immigrant plants have, like their human counterparts, multiplied enormously, and like them have spread all over America. Before considering these lusty newcomers, let us hastily glance at the composition of the native plant population.

Before the whites came to America, the northeastern part of it was covered by trackless forests of which, in their virgin state, scarcely any remain. Ruthless cutting destroyed great areas, and only within recent years has intelligent forest management resulted, locally, in natural reproduction and reforestation. In many places large tracts are now set aside, of which the Palisades Interstate Park is an example near at hand, where nature is allowed to take a course, modified by an enlightened forest policy that will some day renew the glory of American woodlands.

Underneath these great forests grew a wealth of wild flowers, many of which flower early enough in the spring to finish their blooming before the annual spring canopy of leaves cuts off their light. This excessive shade is one of the reasons why so many of our wild flowers become dormant during the summer. Besides these, there are hosts of shrubs and herbs that need more light and are found along the edges of forest clearings, in thickets, or along river basins and lake shores; and their blooming period is not so rigidly controlled by the closing of the forest canopy. From among these "shade-loving" and light-demanding plants all the flowers of our beautiful countryside must come, so that nature has supplied an almost continuous panorama of bloom from the fragrant arbutus and the modest hepatica of early spring to the frost-touched golden flowers of the witch-hazel of late autumn.

One striking characteristic of practically all these native plants is that they thrive best only where the natural conditions are as little disturbed as possible, and scarcely a handful of them ever grew as weeds on cultivated or otherwise disturbed land.

In the appended list, are a few conspicuous native wild flowers, spring-, summer-, and autumn-flowering, grouped as are the specimens of them in the exhibit in Room 306. Nearby are specimens of some representative native forest trees which have played such an important part in making the American landscape what it is. None of the following lists is intended to be exhaustive, but only to illustrate.

NATIVE HERBS

SPRING. — Jack-in-the-Pulpit, *Arisaema triphyllum*; Dog's Tooth Violet, *Erythronium americanum*; Pink Lady's Slipper. *Cypripedium acaule*; Arethusa, *Arethusa bulbosa*; Hepatica, *Hepatica triloba*; Columbine, *Aquilegia canadensis*; May Apple, *Podophyllum peltatum*; Bloodroot, *Sanguinaria canadensis*; Foam Flower, *Tiarella cordifolia*; Trailing Arbutus, *Epigaea repens.*

SUMMER. — Water Lily, *Castalia odorata*; Virgin's Bower, *Clematis virginiana*; Pitcher Plant, *Sarracenia purpurea*; Burnet, *Sanguisorba canadensis*; Prickly Pear, *Opuntia vulgaris*; Swamp Loosestrife, *Decodon verticillatus*; Butterfly Weed, *Asclepias tuberosa*; Oswego Tea, *Monarda didyma*; False Indigo, *Baptisia tinctoria*; Yellow Gerardia, *Gerardia flava*; Purple Gerardia, *Gerardia purpurea*; Cardinal Flower, *Lobelia cardinalis.*

AUTUMN.—Marshmallow, *Hibiscus Moscheutos*; Fringed Gentian, *Gentiana crinita*; Tall Sunflower, *Helianthus giganteus*; Culver's Root, *Veronica virginica*; Joe-Pye Weed, *Eupatorium purpureum*; Salt Marsh Goldenrod, *Solidago sempervirens*; New York Aster, *Aster Novi-Belgii*; Marsh Fleabane, *Pluchea camphorata*; Blackeyed Susan, *Rudbeckia hirta.*

NATIVE TREES

Black Walnut, *Juglans nigra*; Ironwood, *Ostrya virginica*; Sweet Birch, *Betula lenta*; Beech, *Fagus grandifolia*; Chestnut, *Castanea dentata*; Black Oak, *Quercus velutina*; White Oak, *Quercus atba*; Sweet Bay, *Magnolia virginiana*; Tulip Tree, *Liriodendron Tulipifera*; Sassafras, *Sassafras variifolium*; Sweet Gum, *Liquidambar Styraciflua*; Plane Tree, *Platanus occidentalis*; Basswood, *Tilia americana*; Sugar Maple, *Acer saccharum*; Sour Gum, *Nyssa sylvatica*; Persimmon, *Diospyros virginiana*; Ash, *Fraxinus americana.*

Among the 613 immigrant plants now known to grow here without cultivation, the overwhelming majority, like the people, come from Europe. Once landed, their Americanization has been extraordinary. So rapid was their capture of the new land, and so prolifically did they multiply, that the older races shook their heads at a speed of occupancy that boded ill. Neither party to this invasion knew then, as is abundantly evident now, that there was no real controversy as between the newcomers and the ancient American vegetation, for their food habits and home economy were poles apart. It has already been pointed out that native American plants did not like disturbed conditions, but the newcomers literally monopolized such places. In all the hurly-burly of the building of America,—the roads, railways, canals, factory yards, mines, and millions of acres of farms,—this horde of foreign plant immigrants stood ready to cover with a weedy vegetation regions that scarcely any native plants could have successfully occupied. As "weeds," which may, from the farmer's point of view, be defined as plants out of place, these European plant immigrants have spread over all America. Perhaps even the meagre list of them which follows will come as a surprise to many of the older generation of Americans, but to all recent arrivals they will bring back memories of home. From their occupancy of different sites this native and introduced plant growth, competing scarcely at all, makes for variety and beauty in the flora of America, just as the commingling of different human strains makes for a richer community life.

A few of these introduced plants are listed below, together with the country of their origin. Most of them are among our most familiar roadside plants. Surprisingly few of them are trees, but some, like the *Ailanthus*, have spread into remote regions.

Immigrant Herbs

Spring.—Star of Bethlehem, *Ornithogalum umbellatum*; (Europe); Sheep Sorrel, *Rumex Acetosella* (Europe); Prince's Feather, *Polygonum orientale* (India); Lamb's Quarters, *Chenopodium album* (Europe); Chickweed, *Cerastium vulgatum* (Europe); Water Cress, *Radicula Nasturtium-aqualicum* (Europe); Dandelion, *Taraxacum officinale* (Europe); Coltsfoot, *Tussitago Farfara* (Europe).

Summer.—Common Poppy, *Papaver somniferum* (Europe); White Mustard, *Brassica alba* (Europe); Mossy Stonecrop, *Sedum acre* (Europe); Red Clover, *Trifolium pratense* (Europe); White Melilot, *Melilotus alba* (Europe); Alfalfa, *Medicago sativa* (Europe); Prickly Lettuce, *Lactuca scariola* (Europe); Devil's Paint Brush, *Hieracium aurantiacum* (Europe); Lovage, *Loevisticum officinale* (Europe); Hemp Nettle, *Galeopsis Tetrahit* (Europe); Peppermint, *Mentha Piperita* (Europe).

Autumn.—Bittersweet, *Solanum dulcamara* (Europe); Catnip, *Nepeta Cataria* (Europe); Common Groundsel, *Senecio vulgaris* (Europe); Scotch Thistle, *Onopordum Acanthium* (Europe); Bachelor's Button, *Centaurea Cyanus* (Europe); Chicory, *Cichorium Intybus* (Europe); Galinsoga, *Galinsoga parviflora* (Tropical America); Sneezeweed, *Achillea Ptarmica* (Europe); Butter and Eggs, *Linaria vulgaris* (Europe); Foxglove, *Digitalis purpurea* (Europe); English Plaintain, *Plantago lanceolata* (Europe); Common White Daisy, *Chrysanthemum leucanthemum* (Europe); Tansy, *Tanacetum vulgare* (Europe).

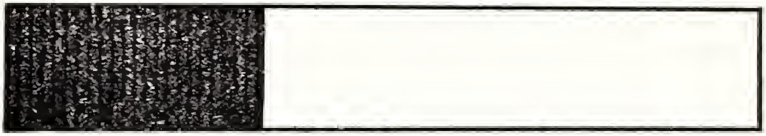
Immigrant Trees

Weeping Willow, *Salix babylonica* (Asia); White Mulberry, *Morus alba* (Europe and Asia); Paper Mulberry, *Broussonetia papyrifera* (Asia); Horsechestnut, *Aesculus Hippocastanum* (Asia); Norway Maple, *Acer platanoides* (Europe and Caucasus); Paulownia, *Paulownia tomentosa* (Japan); Ailanthus, *Ailanthus glandulosa* (China).

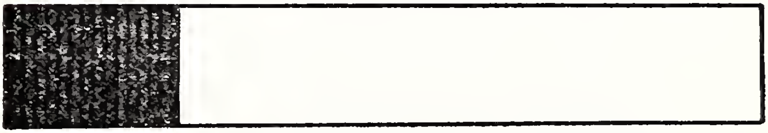
Newcomers to America then, will find here a native flora thoroughly consolidated in its occupancy of the natural undisturbed regions, and from its size and importance dominating the floristic tone of the country. Foreign plants, like all new arrivals, are often obliged at first to occupy less desirable sites; and, unlike the people, there seems no chance of their becoming assimilated into the native vegetation, as thousands of human immigrants have entered into the very core of material and spiritual America.

Diagrams Showing Proportions of Native and Immigrant People and Plants

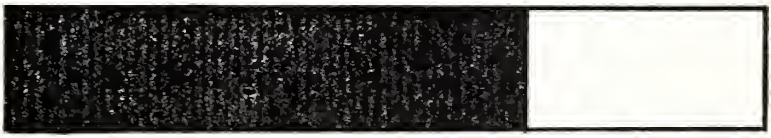
Black represents foreign: white, native.



The proportion of foreign and native born people in Greater New York.
(From latest available census returns.)



The proportion of foreign and native plants growing without cultivation near the City.
(From Taylor's "Flora of the vicinity of New York.")



The proportion of Old and New World food plants used here.
(From De Candolle's "Origin of Cultivated Plants.")

Let us consider next one contribution which foreign plants have made to America which is beyond price. No struggling immigrant who comes to this land of opportunity but must feel that he should bring to his new country some contribution from the Old World, some recompense for the chances which the New World holds out for him. As may be inferred from the diagram, Old World food plants, long since introduced here, have actually made this new country habitable. Except corn, all the cereals, as well as sugar, banana, coffee, and tea have come from the Old World, which, in overwhelming proportion, has supplied the food plants of the earth. While such important plants as corn, potato, pineapple, and chocolate are natives of the New World, practically all the other important food plants came from abroad. This invasion of the New World by the Old World useful plants began years before the immigration problem became serious. But today there need be no immigrant so humble but that he can feel, with a certain justifiable pride, that the Old World has contributed more than its share of things botanical to the New; that his wish to come and share the advantages which the common food plants of the Old World made possible here, will be respected and understood; and that he too may take his part, both with the native and immigrant population in the making of America.

A brief list follows of the more important food-plants showing the probable country of their origin.

American Food Plants

"Alligator Pear," *Persea gratissima* (Tropical America); Blackberry, *Rubus* sp. (Temperate America); Guava, *Psidium Guajava* (Tropical America); Pineapple, *Ananas sativus* (Tropical America); Lima Bean, *Phaseolus lunatus* (Tropical and Temperate America); String Bean, *Phaseolus vulgaris* (South America); Corn, *Zea Mays* (North and South America); Red Pepper, *Capsicum annuum* (Tropical America); Potato, *Solanum tuberosum* (South America); Sweet Potato *Ipomoea Batatas* (Tropical America); Pumpkin, *Cucurbita Pepo* (Tropical America); Tomato, *Lycopersicum esculentum* (Peru); Chocolate, *Theobroma Cacao* (Tropical America); Black Raspberry, *Rubus occidentalis* (Temperate North America).

Old World Food Plants

Apple, *Pyrus Malus* (E. Europe and W. Asia); Pear, *Pyrus communis* (S. Europe and S.-W. Asia); Quince, *Cydonia oblonga* (Cent. and E. Asia); Apricot, *Prunus armeniaca* (China and Japan); Peach, *Prunus Persica* (China); Mango, *Mangifera indica* (India); Asparagus, *Asparagus officinalis* (Europe and Asia); Beet, *Beta vulgaris* (Europe and Asia); Cabbage, *Brassica oleracea* (Asia); Carrot, *Daucus Carota* (Europe and Asia); Cherry, *Prunus Avium* (Asia); Date, *Phoenix dactylifera* (Arabia and N. Africa); Fig, *Ficus Carica* (S. Arabia); Lemon, *Citrus Limonia* (India); Orange, *Citrus Aurantium* (S. Asia); Banana, *Musa sapientum* (Tropical Asia); Pea, *Pisum sativum* (Europe and Asia); Wheat, *Triticum sativum* (Mesopotamia); Rye, *Secale cereale* (S. Europe and Cent. Asia): Barley, *Hordeum sativum* (W. Asia); Rice, *Oryza sativa* (Tropical Asia); Oats, *Avena sativa*

(W. Temp. Asia); Cane Sugar, *Saccharum officinarum* (E. Asia); Tea, *Thea Sinensis* (Asia); Coffee, *Coffea arabica* (Arabia); Celery, *Apium graveolens* (Europe and Asia); Onion, *Allium Cepa* (Asia); Parsley, *Petroselinum hortense* (Europe); Parsnip, *Pastinaca sativa* (Europe); Spinach, *Spinacia oleracea* (Asia); Turnip, *Brassica Rapa* (Europe); Lettuce, *Lactuca sativa* (Europe); Radish, *Raphanus sativus* (Europe).

Not only has the Old World supplied us with the great majority of our food plants, but a goodly proportion of the better known garden herbs and shrubs have come from abroad. In the following lists of garden plants those of New World origin come first. It will be noted that some of our most attractive and beautiful ornamental plants are of Old World origin.

GARDEN PLANTS OF NEW WORLD ORIGIN

Beard Tongue, *Pentstemon* sp.; Dahlia, *Dahlia*, sp.; Flowering Dogwood, *Cornus florida*; Mariposa Lily, *Calochortus* sp.; Monkey Flower, *Mimulus* sp.; Nasturtium, *Tropaeolum* sp.; Quamash, *Camassia* sp.; Snowdrop Tree, *Halesia tetraptera*.

GARDEN PLANTS OF OLD WORLD ORIGIN

English Daisy, *Bellis perennis* (Europe); Plume Poppy, *Bocconia* sp. (China); China Asters, *Callistephus chinensis* (China); Canterbury Bell, *Campanula medium* (Europe); Cockscomb, *Celosia* sp. (India); Marguerite, *Chrysanthemum frutescens* (Canary Islands); Hollyhock, *Althaea rosea* (Europe, Asia); Chrysanthemum, *Chrysanthemum indicum* (Asia); Peony, *Paeonia* sp. (Europe and Asia); Carnation, *Dianthus caryophyllus* (Europe and Asia); Tulip, *Tulipa suaveolens* (Southern Russia); Barberry, *Berberis vulgaris* (Europe); Lilac, *Syringa vulgaris* (Europe); Forsythia, *Forsythia* sp. (Europe and Asia).

NORMAN TAYLOR.

NOTICES

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays at 10 a m. The Laboratory Building, containing the library, herbarium, and offices, is open daily (except Sundays), from 9 a. m. until 5 p. m. (Saturdays, 9–12). The Conservatories are open April 1-October 1, 10 a. m.–4:30 p. m. (Sundays, 2-4:30); October 1-April 1, 10 a. m.–4 p. m. (Sundays, 2-4).

The Garden may be reached by Flatbush Avenue trolley to Malbone Street (Empire Boulevard); Franklin Avenue and Lorimer Street trolleys to Washington Avenue; St. John's Place trolley to Sterling Place; Ninth Avenue, Union Street, Vanderbilt Avenue, and Smith Street trolleys to Prospect Park Plaza and Union Street, and Brighton Express, Broadway (B.R.T.) Subway, to Prospect Park Station, north exit; Interboro Subway, Eastern Parkway-Brooklyn Museum Station, east exit.

A docent will meet parties by appointment and conduct them through the Garden. This service is free to members of the Botanic Garden and to teachers with classes; to others there is a nominal charge of 25 cents an hour for parties of less than three, and 10 cents a person per hour for parties of three or more.

Subscription for LEAFLETS **fifty cents a series** (comprising ten or twelve numbers); free to members of the Botanic Garden and to teachers.

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BROOKLYN BOTANIC GARDEN
LEAFLETS

SERIES IX BROOKLYN, N.Y., NOVEMBER 9, 1921. No. 10

EDUCATIONAL PROJECTS

The term project has caused much confusion in the minds of many educational people, due to the fact that teachers have been calling projects problems, and problems projects. In order to clear up hazy notions it might be helpful to remember this; namely, that a problem is something to be solved, while a project has a definite practical outcome. We sharpen our wits in the solving of a problem, while we make adjustments and concrete contributions to everyday life when we work out a project. Dr. McMurry defines a project thus: "A strongly, wisely organized body of thought focused upon an important center of practical knowledge with a definite purpose." The dictionary defines a project as a plan, a scheme; a problem as a question to be solved. One may solve the problem but never apply the solution in any practical way; still the problem is solved. Educationally, at least, the project goes a step farther than the problem in the taking of definite knowledge and applying it to a *practical end in everyday life* under the given existing everyday conditions.

Since the day of the little rural school and up to the present time both problems and projects, unnamed as such, have walked hand in hand. In all cases the educational values have rested in the interpretation and application made by individual teachers. Articles which have appeared in different educational journals during 1921 have cleared up only in part our confusion concerning projects.

Take this concrete example, a real case; the grounds about a certain district school needed draining. The drainage involved ascertaining the proper drop for pipe laying. When this was determined mathematically the problem, as such, was solved. Now the project enters in, which involves the questions, how much pipe is necessary for this work, where shall it be bought, how much will it cost, where is the money to come from? Then the practical solution follows; the pipe is bought, and lastly the boys and girls do the actual work, thus contributing to their school and community.

Perhaps one of the greatest contributions of the project plan to education is this: that the individuals concerned must constantly consult both real life and books rather than only parents and teachers.

Ever since the Brooklyn Botanic Garden started its work for children about eight years ago it has been carrying out, naturally and simply, this so-called new phase of education; and some of the projects we have been using have been selected for this LEAFLET, as follows:

PROJECT 1: *To determine the viability of seeds.*—The application was made in our work of distributing the penny packets of seed from the Brooklyn Botanic Garden to the children of the Borough of Brooklyn.

To elaborate this project, one which might be used in any school where there is a garden or with any groups of children having home gardens, certain seeds are used, those which are to be planted in the outdoor garden, or, in the case of the Brooklyn Botanic Garden, to be sent out to the public. Give one or two individuals, according as the project is worked singly or in groups, a certain number of kinds of seed. Then show the common method of germinating seed, telling the number of seeds to use for the test, using the same number that is used in scientific tests, one hundred small, or fifty large and fifty medium seeds. Provide or obtain at home the proper materials; blotter, Petri dishes, or saucers. Try the tests over several times to check them, as no one test is sufficient to determine the real viability of any given seed. One should look out for varying conditions of heat, moisture, and light in this experiment, as these are factors in the test. The student then changes the figures obtained from his tests into equivalent percentages. This is a practical project, not only to assist the work of gardening, but to use at the time when children are taking up the subject of percentage in arithmetic. Such a project, that of using different kinds of seeds, might be employed with an entire class and the results checked up in class, the boys and girls taking the results of the different individuals or groups. Various side lines develop from such a project, as, for example, the following: ascertaining the length of time required for germination; depth to plant seed; plant groups to which the given seeds belong; countries from which the different seeds originate. The application comes as these seeds are used in the school and home gardens of Brooklyn, and the final practical results checked up at the time of the annual fall exhibit.

PROJECT 2: *To test garden soil for acidity.*—In this project one might make the litmus test for acidity before an entire class, and then have each child test out the soil of his own garden or school garden, or samples sent in by neighbors. The method used is the regulation test where blue litmus is dipped in an acid. The blue litmus paper changes in color to red. A sample of soil, say two table-spoonfuls, is put into a glass of water. Stir thoroughly. The soil settles to the bottom of the glass. Dip blue litmus paper into the water and note result. Definite directions for procedure in case of acidity of the soil are sent to the garden owner. The application of this knowledge, the final planting of the garden, and the practical results obtained in the betterment of soil conditions, represent the various steps in this project plan.

PROJECT 3: *To determine the best flowers to grow in city backyards.*—The application is obvious. The students work on this project and also on Project 4 in the children's garden area, a space set aside for this purpose, planting the material with which they are experimenting. The hardiest varieties are tried out at home in backyards all over the city. The results are turned in to be used for the benefit of the general public.

PROJECT 4: *To determine ten shrubs best calculated to suit the needs of a given community both as to decorative effect and adaptability.*—This problem involves studying not only the soil, but the shrubs, time of bloom, type of fruit and leaf, and working out

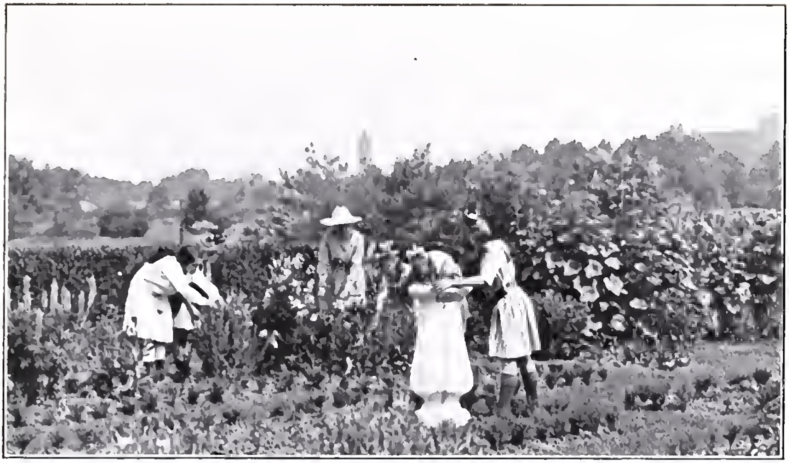

FIG. 1—The flower garden: a project theme used by a group of girls at the Brooklyn Botanic Garden. Plan of garden, starting of seedlings, planting of same, care of garden, all were active parts of the work.

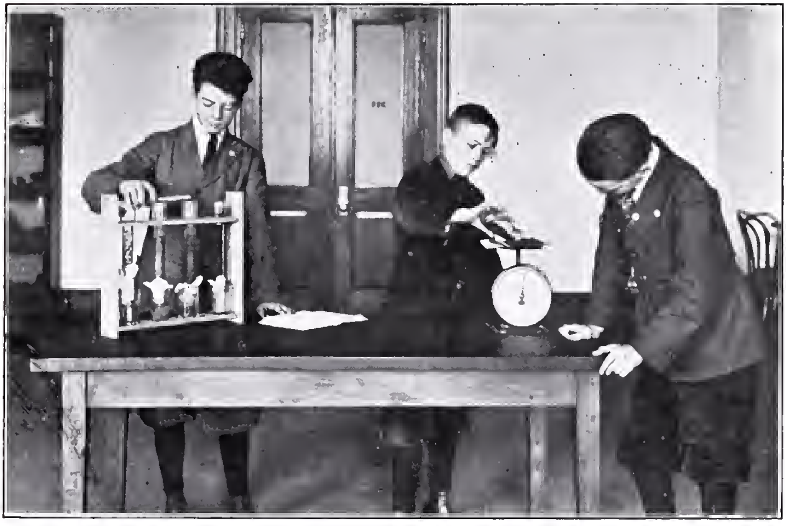

FIG. 2—Testing garden soil; samples of soil sent to the Brooklyn Botanic Garden from small backyard garden plots in Brooklyn. Tests made by high school boys.

tables to show height, time of bloom, and other interesting qualities which determine the choice of a given shrub. For the practical outcome note that given under Project 3.

PROJECT 5: *To plan a backyard garden.*—This project should be given out in February. Plans must be drawn to scale. Distance between plants should be carefully considered in order to avoid overcrowding. Choose the type of plant, which, in the choosing, will determine the best economic use of a given space. This project has been used constantly at the Brooklyn Botanic Garden by the boys and girls who have been in the garden more than two years. It involves, on their part, a good deal of study and thought, so that, in general, crops of the same nature, such as two leaf crops, for example, may not come side by side. Plans should be approved by the supervisor or teacher, and the mistakes jotted down by the pupil as the season goes on. Such a project as this is very desirable to use in home garden work. Not all errors need be carefully culled out by the supervisor, for by allowing a certain freedom in choice a child realizes the results of his original mistakes. There is no phase of the work so good as this to show boys and girls the results of poor judgment. If you plant a crop so that it overshadows another, thereby developing an inferior product, the result of that mistake you see quite plainly. It stares you in the face all summer. It is better for a child to meet some such mistakes than simply to have them discussed, revised, and corrected by the teacher.

It might be of interest to state that a record of the value of the crop is kept, and that this present season there was taken from our children's garden (about three-quarters of an acre) over
$3200 $2000 worth of vegetables. It might be appropriate to say also that the money value of the garden, even viewed in the light of a project, seems of far less importance than does what we call the character value. Projects considered in terms of money alone are scarcely worth considering; although some educators place a large importance upon this money factor.

There are endless projects like these which are constantly being used by the older boys and girls at the Botanic Garden. They all work around the theme of gardening, which is but an application of one phase of the general subject called nature study. Because of the opportunities of such a place as the Brooklyn Botanic Garden, gardening has been chosen as a center of interest about which other subjects are grouped. These other phases of nature study work out simply and naturally from the main center, and the moment any phase of our chosen subject is forced or dragged in, it fails of its possibilities. The whole point of the work is then lost. Perhaps the greatest value of project work lies in the possibilities it opens up for the young mind, of development, of self-reliance, and vision; for the opening up of avenues of interest in any field of endeavor is an onward step in education, not only of the individual, but of the community.

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